POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884
ELY C. HUTCHINSON, *Editor*

Volume 73 NEW YORK, MAY 19, 1931 *Number 20*

Dr. Albert A. Michelson

WHEN Dr. Michelson was graduated from the Naval Academy in Annapolis in 1873, the superintendent is said to have told him that if he would give less attention to "those scientific things," and more to gunnery, there might come a time when he would know enough to be of some use to his country.

He has just passed away at the age of 78, with a record of exceptional achievement which will cause his name to be honored and his contributions to be quoted and employed when people have come to wonder why naval gunnery ever should have been.

He was brought to this country from Strelno, Germany, where he was born in 1852, and upon his graduation from high school in San Francisco sought admission to Annapolis. He passed the examination successfully, but failed to get the appointment. Nothing daunted, he went to Washington to seek appointment by the President, but found that President Grant had used up all of his ten appointments. He persisted, however, and made so favorable an impression that the President appointed him anyhow.

James Clark Maxwell's work on "Electricity and Magnetism" was published the year of Michelson's graduation. Serving in the Department of Physics of the Academy, Michelson became intensely interested in the theory that light was an electro-magnetic wave motion, and his life's work was decided.

He measured the intangibles with which he dealt in terms of inconceivable minuteness, and the instruments and methods which he devised have given to the astronomer means of precise celestial measurements and of determining the composition of the contents of distant space. With Morley he demonstrated the absence of ether drift, which has so much significance in the theory of relativity, for the awakening of the conception of which he was credited by Einstein.

The velocity of light is of great and growing importance. Michelson had made two measurements of it, the latest in 1928, with a probable error of not more than 1 part in 100,000. Still unsatisfied, he undertook, in his last years, another experiment, performed in a vacuum tube a mile long and three feet in diameter, to eliminate atmospheric effects. The tests were under way when he was stricken, and almost his last words were a dictated introduction to the final report.

He was a member of many learned societies, was the recipient of many honors, wrote little and talked less. But whenever the tale is told of man's evaluation of his place in the universe, Albert A. Michelson will stand forth prominent among those who have blazed the way.

EDITORIALS

A Glimpse Into the Past

THE ENGINEERING PROFESSION is so absorbed in meeting the demands of the present and pressing forward toward accomplishment of the future that many incidents having vital bearing on such progress are either lost sight of altogether or remain for posterity to glean from colorless reports devoid of that human interpretation so necessary to their correct appraisement.

Engineers, as a rule, are too busy to set down these events as they occur, and seldom record them in retrospection. A few biographies have been written of men who have played important rôles in engineering progress, but autobiographies are a rarity. Therefore, of more than passing interest is a book just off the press entitled "The Autobiography of an Engineer" by W. L. R. Emmett.

Interwoven with the many reminiscences of Mr. Emmett's career is much first-hand information dealing with the early development of the steam turbine in this country. One is taken back thirty-five years to some of the early trials of the central stations. The inception and progress of turbine-electric drive for ships, at times in the face of formidable opposition, is most fascinating, as is also the story of the mercury boiler. Throughout, the reader is taken behind the scenes and catches a glimpse of the personalities, the foresight as well as the peculiarities, of those men actively identified with such progress. It is these human qualities and the small events that count.

From a publishing standpoint, autobiographies may not be attractive, but engineering literature would be richer if there were a few more.

Clean Exhaust Steam

THE BELIEF that exhaust steam from reciprocating engines contains too much oil to permit its use directly in processes has led to the rejection of this type of prime mover in many plants, despite its efficiency at high back pressures. Similarly, with the adoption of high steam pressures, it has been assumed that the oil in the condensate would imperil the boiler.

Are these fears well grounded?

In most plants processing does not entail the direct admission of steam into the vats or tanks. Where heating coils are employed, oil in the steam supply is not serious. Even if steam must be applied directly, present designs of separators will eliminate practically all of the oil, and the cleaned steam is safe for all but the most delicate of processes. Of course, the better plan is to install heat exchangers, which insure clean process steam and a scale-free feed water. Condensate containing oil may then be clarified by an approved filter method or by the new centrifugal process, either of which should protect a boiler.

The dread of oil in boilers may be an inheritance from the engineer of yesterday, who found that oil did blister boiler sheets. The old-time boiler more often was of the fire-tube design and the period of week-end bank permitted oil to settle on the bottom sheet, where it caked and blistered. With the present practice of rapid steaming in water boilers there should be less opportunity for oil to settle. Twenty years ago the designer of the Stanley steam automobile introduced the engine's lubricant into the feed water, and no blisters resulted.

It might be well for someone to test the matter, adding different amounts of oil until blistering occurs.

New York Power Authority

WHEN Governor Roosevelt announced the appointment of the members of the St. Lawrence Power Development Commission, the feeling prevailed that politics and preconceived points of view had been put aside in the genuine desire to establish the fundamentals upon which the state might be justified in entering into the power business. This impression was enhanced when the full report of the commission was made public January 15, and its eleven recommendations were generally regarded as the fair-minded conclusions of a group of men well qualified to consider facts without prejudice.

Such a result could hardly have been secured if the personnel of the commission had not been of the character to achieve it.

The Governor unquestionably added to his prestige and gave something definite to the public confidence by his commission appointments.

But, whatever the gain then, the people who understand something of the problems involved, and feel that impartial consideration of all points of view is desirable in all things, are sure to be bitterly disappointed with the Governor's May 7th announcement of appointees to the State's Power Authority under the Cornaire bill.

The records of the appointees and their former activities where related to the power question, indicate forcibly the kind of thinking that may be expected from this new group, and there is little or no likelihood of the Power Authority preserving the public effect that followed the efforts of the St. Lawrence Power Development Commission.

Far away as the conclusion of the project has always been, the Governor's action, should the appointments be confirmed by the Senate, will make it farther.

Necessity Wins Delaware Diversion Case

SOME of the hardest-fought political and legal struggles in recent years have been over our water resources. Uses for our rivers are many and varied. Municipal water supply, sanitation, navigation, river regulation, power and nature conservation rank as most important along the Atlantic Coast and in the Mississippi Valley.

Conflict of the various interests has frequently gone to the United States Supreme Court, and numerous decisions indicate a tendency to adjudicate disputes on the basis of common-sense rather than ancient doctrine. Within the last twelve months two decisions have attracted national attention. One of these disallowed the claims of Chicago for diversion from Lake Michigan and the other upheld New York City's rights to divert water from the upper Delaware River into its water system.

In the Delaware River decision the important point of law is that, along with other findings, the Court refused to recognize the prior right of the territory abutting the lower reaches of the river. It was on this doctrine that New Jersey claimed exclusive use of the water, even if a large part of it did originate in New York State. Power and navigation were secondary issues in this case. The prima facie case was New York City's necessity against New Jersey's contention for something she had no use for. And necessity won.

Chicago's claims were for waters, that did not originate within her State, to be used for sanitation purposes which could be as well or better accomplished by other means. The diversion has not only interfered with navigation on one of the largest inland waterways in the world, but has taken water equivalent to one-half million horsepower out of a section of Canada and New York State where water power is necessary for industrial development. Necessities of power and navigation were here adjudged supreme.

Power developments and other improvements have, in many cases, been retarded by the exaggerated claims of state and municipal governments, for no other apparent reason than political expediency. Recent decisions of the United States Supreme Court should have a salutary effect in discouraging this useless and wasteful practice.

"Engineering Societies Monographs"

THE PROBLEM of publishing abstruse or highly specialized engineering treatises has long been discussed with little result. It is clear that any given publication of this nature must be useless to ninety-nine engineers out of a hundred—that it is a serious waste of paper and ink to reproduce such material in media of broad circulation. Yet the hundredth engineer, working on a special problem, may find such a treatise tremendously helpful. And his work, built on this foundation, may eventually be of great benefit to the ninety-nine engineers concerned with practical everyday problems.

Toward the solution of this problem the Engineering Societies have now made a definite and important contribution. They propose, in an announcement just released, to publish a series of "Engineering Societies Monographs." A committee representing the Engineering Societies Library and the four Founder societies will have editorial supervision.

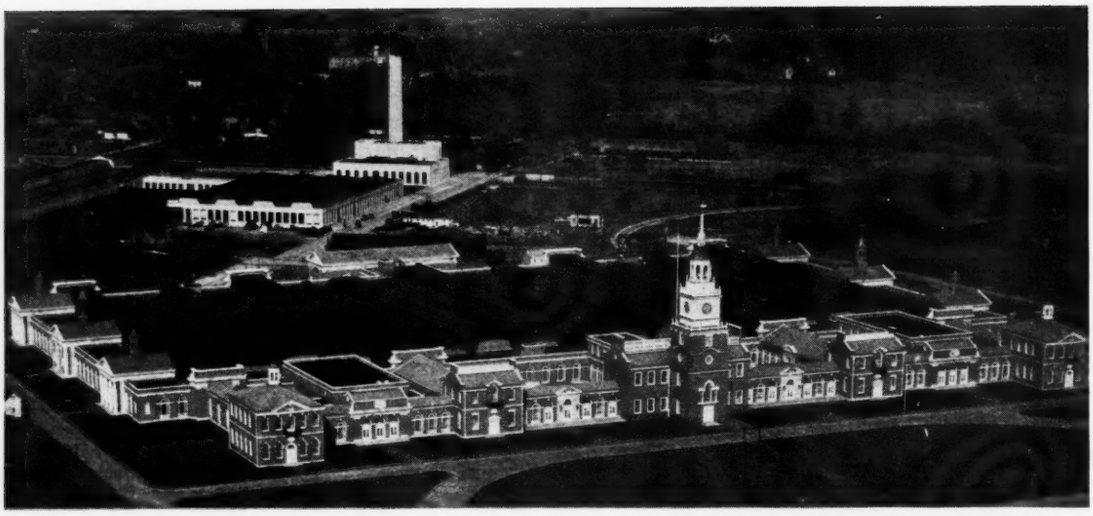
This will be a genuine service, if it provides permanence to intellectual advances that would otherwise be lost to the profession. But a word of warning is perhaps in order. While all must admit that abstruse and highly specialized volumes may be of tremendous ultimate value to industry and to civilization, it does not follow that every abstruse monograph is thus valuable. In fact it sometimes happens that a profusion of mathematical symbols, garnished with ponderous verbiage, conceals a lack of clear thinking. Many examples could be cited.

Undoubtedly the committee appointed will be competent to distinguish between such displays and real contributions to engineering knowledge.

▼

POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason



Ford museum is fronted by Colonial group of buildings

Ford Museum Heated by Hot Water Under Forced Circulation

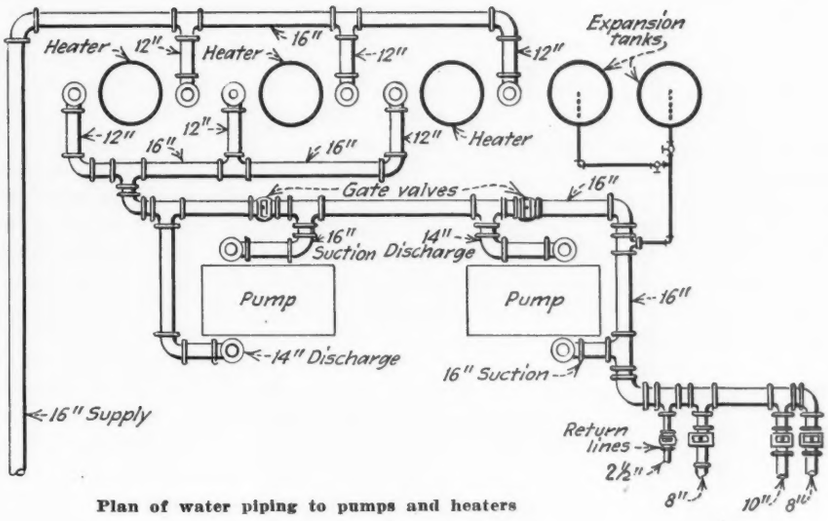
In a system containing 160,000 sq. ft. of equivalent direct radiation, unique features are the design of the high-pressure vertical heaters and the use of throttling valves in the drain line of each heater. By adjusting the height of the condensation in the tubes the area of the steam surface exposed to the circulated water is varied in accordance with outdoor temperature requirements. The steam pressure forces the condensation back to the boiler plant, 1,600 ft. distant

AT DEARBORN, MICH., the buildings that are to house Ford's great industrial museum and technical school have been completed. They contain an enormous exhibition hall measuring 450x800 ft., across the front of which is a group of seven buildings having Independence Hall of Philadelphia as an architectural model. This group, which is connected with the museum by arcades with open courts between, includes a central administration building, a theater seating 600, and classrooms for students of the Edison Institute of Technology.

At the rear of the exhibition hall is a service building to house the machinery and equipment needed to service these several structures. High-line service from the Rouge plant and from the Detroit Edison system has been made available and attractive instrument and control boards are a part of the decorative ensemble. In addition to the building heating equipment, which is now functioning, equipment for cooling and circulating drinking water is provided. Two 7,000-g.p.m. drainage pumps are ready to handle storm water from the roofs, and there are other pumps to serve the lawn sprinkler system and guard against fire. The domestic hot-water system comprises heaters and circulating pumps operated in the same manner as those of the heating system. Space has been reserved for a large air compressor and a 500-kw. motor-generator set to provide direct current. An accompanying photograph indicates the elaborate setting in which this equipment has been placed.

Of these various services the heating has points of special interest. Through tunnels and the basement of an intervening structure steam at 150 lb. pressure is carried 1,600 ft. to the service building from a new boiler plant to be described in an article in *Power* early in June. Lack of a basement under the museum proper, the impossibility of grade for gravity return of the condensation to the heating plant, the great area of the structures, and the desire for consistently uniform heating, were some of the factors determining the installation of a forced-circulation hot-water system. With such a system it was possible to obviate all thermostatic temperature control except in the theater and school, where separate fresh-air ventilation is required. All pumps, receivers and reducing valves in connection with the steam supply and condensate return are eliminated, and without the necessity of adjusting individual radiators, exact regulation of the entire heating system from the service building is possible.

High-pressure heaters of special design were chosen because they could be obtained at less cost due to the smaller heating surface required, reducing valves were eliminated, and the steam pressure could be utilized to return the condensation 1,600 ft. to the boiler plant without the use of pumps and receivers. This is accomplished by the simple expedient of providing two 2-in. hand-operated throttling valves in the drain line from each heater. Adjustment of these valves raises or lowers the condensation in the tubes of the vertical heater, varying the tube surface exposed to the steam in accordance with the heating-water temperature desired, or, more specifically, with the determining factor, which is the outdoor temperature. At the same time the tube surface has been figured so that under maximum conditions with the incoming steam at 150 lb. pressure the condensation will be cooled below 220 deg. before leaving the heater shell to prevent flashing. A thermometer on the hotwell gives continuous indication of the condensate temperature. The drain throttle valves permit the flow of steam from the boilers to the heater and the return of the condensation to the feed-water heater to be adjusted exactly to give and maintain any heating-water temperature between the limits of 100 and 220 degrees.

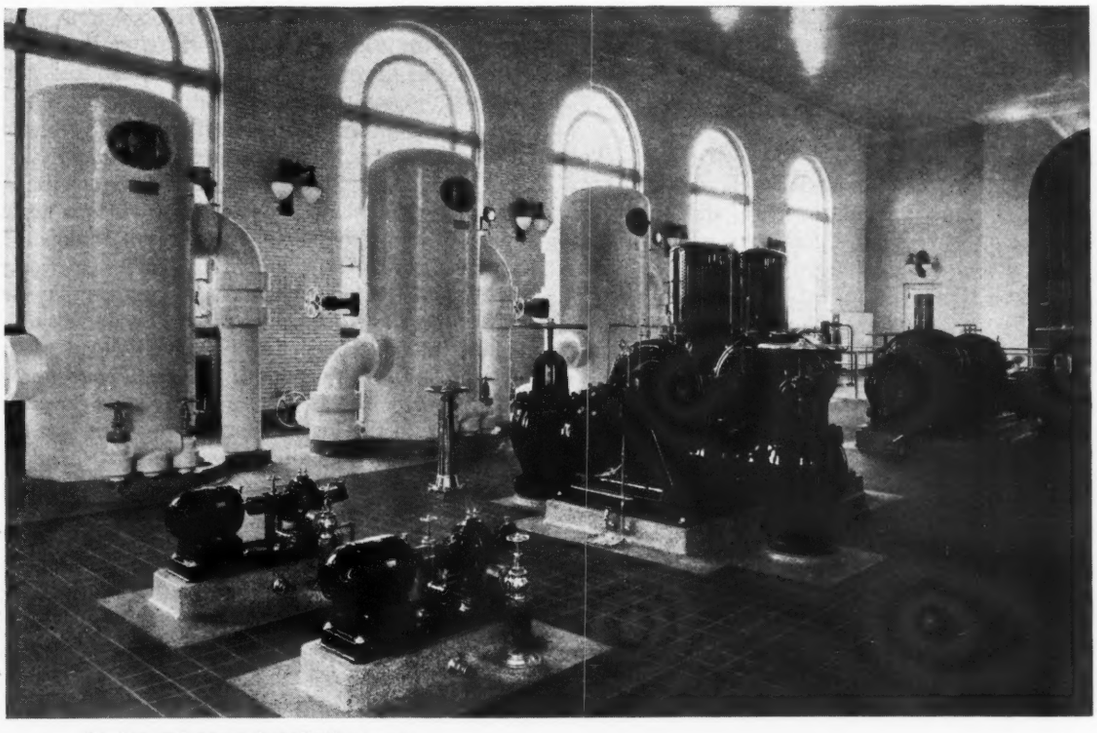


Plan of water piping to pumps and heaters

In the design of these heaters the tube sheets were placed to provide a large volume for the steam in the upper part of the heater and below—a hotwell of sizable proportions. Heating requirements for the museum and the front group of buildings called for three live-steam heaters capable of raising the temperature of 6,000 gal. of water per minute 15 deg. with steam at 125 lb. pressure. The three heaters will condense a maximum of approximately 50,000 lb. of steam per hour.

Two 14-in. water-circulating pumps, driven by direct-connected 200-hp. 4,600-volt synchronous motors, are provided. As the method of operation is to maintain constant circulation at all temperatures, the constant full-load efficiency of 89 per cent is maintained on the pumps. Dependent upon the weather, the drop on the system ranges from 6 to 12 degrees.

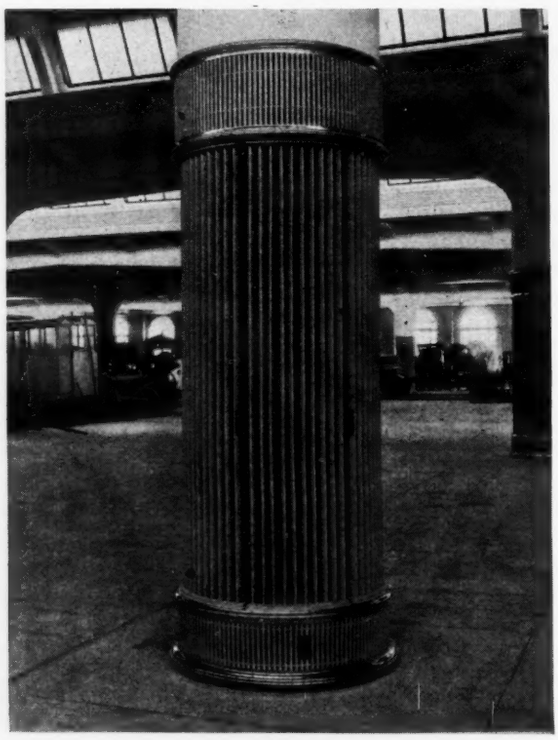
Exhibition space in the museum is one immense room broken only by the 180 columns supporting the roof. Heating is entirely by direct radiation. In sheet-steel radiators of distinctive design and construction incasing each of the building columns, 50,000 sq.ft. of surface is provided. Each radiator consists of six interconnected



Heater and pump installation serving museum and adjoining buildings

elements with 1½-in. common supply and return lines to overhead mains concealed in the steel and glass monitors of the roof. These mains are exposed, and in combination with radiators along the walls and additional concealed radiators in the monitors bring the total radiation in the museum to 120,000 square feet.

An equivalent of 40,000 sq.ft. of direct radiation heats the buildings at the front of the museum. Cast-iron radiators concealed behind grilles are used. In addition to sufficient direct radiation to maintain under thermostatic control a reduced temperature in the school and theater when unoccupied, indirect surface is provided for ventilation. Twelve thousand cubic feet per minute of outdoor air is supplied to the school through an air washer and tempering coils, and an equal volume of air



One of the 180 column radiators in the museum

is removed by motor-driven disk exhaust fans. The ventilating requirement for the theater is 20,000 c.f.m.

All of the radiation in the museum and the front buildings, direct and indirect, is connected to a common hot-water circuit consisting of a 16-in. outside diameter supply main and four return mains sized as follows: one 10-in. line from the front group, one 8-in. line from each side of the museum and one 2½-in. line from the service building. A gate valve in each return line is operated from a floor stand in the service building by means of which the flow to the specific section served may be varied by increasing or decreasing the drop for additional temperature adjustment to offset such variables as wind on one side of the building. Two expansion tanks with full-length water gages provide for adjustment of the water in the system.

To date it has been found unnecessary to manipulate these return valves. Accurate figuring of drops in all direct and shunt circuits has assured good circulation. In fact the job as a whole has functioned perfectly, including the unique throttle-valve adjustment of the surface in the heaters. Robert O. Derrick, Inc., of Detroit, was architect and engineer.

Getting the Most Out of Existing Equipment

By WILBUR D. LAWSON

NOT LONG AGO a good example of how much could actually be saved by giving a small amount of attention to fundamental principles came to my attention, and it is the result of that investigation that forms the material for this article. An oil burning plant in the metropolitan section of New York City was investigated. The conditions found will compare with many other plants throughout the country where either oil or coal is used for steam-generating purposes.

Although the steam cost, per 1,000 lb., at this plant is not as low as in some oil-burning plants, the comparison of the cost before and after making the investigation serves to illustrate an important point. The improved operating results were obtained by making a few changes in operating methods and not by a change of any kind in the actual equipment. The final analysis showed an increase in the operating efficiency of between 7 and 8 per cent and a reduction in the cost of 1,000 lb. of steam of 4½ cents.

The steam-generating equipment consisted of six water-tube boilers. Four of the units were equipped with two burners each, while the two remaining units had three burners each.

The draft control was well-designed, but not as effective as it should have been, due to the lack of necessary instruments to indicate what adjustments should be made. A regulator was installed on the main damper, but it was out of order; hence the only control was by hand. What adjustments to make and when to make them was left entirely to the operator. The remainder of the steam-generating equipment in this plant was comparable to the ordinary plant and needs no further description.

The load consisted of a fairly constant process and engine load. Occasional peak demands occurred in the process, but they were of short duration and did not tax the steam-generating equipment.

The only meters in the plant were a water meter attached to the feed-water heater and an old CO_2 instrument connected to each boiler. The original plan of equipping this plant with instruments was excellent so far as it went, but the job was only half done. It is important to know how much coal, oil, steam or water is being consumed or generated, as the case may be. After these items have been properly recorded, a ratio may be established which will tell how well the work has been done the day, week or month before. Those who want up-to-the-minute information will augment these data with records from the instruments telling how well the whole process is being conducted. The two most important instruments that measure how well the process is progressing are the CO_2 meter and the flue-gas temperature recorder.

A survey was made at this plant under the usual operating conditions, with the normal operating methods in force. The customary number of boilers on the line consisted of five units, each boiler taking care of one-fifth of the load. The results obtained under these conditions may be called the typical operation, and set up in the form of a "heat balance" as shown in the accompanying table.

RESULTS OBTAINED BEFORE AND AFTER SURVEY

	Per Cent		Per Cent
Efficiency	70.4	Efficiency	77.5
Stack loss	13.4	Stack loss	9.2
Unpreventable losses.	16.2	Unpreventable losses.	13.3
	100.0		100.0

In this plant the only loss that could be controlled was the stack loss. The other losses, known as the loss due to moisture and hydrogen in the oil, and radiation and unaccounted-for loss were grouped together under one heading as unpreventable. With these facts available our efforts were concentrated upon the one loss which could be controlled.

With the assistance of adequate combustion instruments a complete run upon all operating boilers was made to establish the normal operation of each unit. This study disclosed a low average CO_2 percentage, and, in some cases, high exit gas temperatures. It was also discovered that too much boilers capacity was on the line to maintain good combustion, as any attempt to improve the combustion conditions, by reducing the amount of excess air, resulted in blowing of the safety valve.

The first step was the removal of one boiler from the line. This accelerated the combustion in the remaining four units and improved the operation considerably. Further studies showed that there was still a large amount of excess air present. This was corrected by careful regulation of the uptake dampers, in conjunction with the combustion instruments. By carefully watching the results with the new adjustments, the CO_2 percentages averaged well over 12, occasionally as high as 14 and 15. The temperature of the exit gases also dropped. The result of improving the CO_2 average and reducing the exit temperatures was a marked reduction in the actual loss up the stack.

A complete set of recording instruments was finally installed, including an oil meter, CO_2 instruments on each boiler, flue-gas temperature recorders on each unit, feedwater temperature recorder and a recording steam pressure gage. Information could then be taken from the records and properly coordinated with all of the significant facts concerning the operation of the entire power plant.

These records have been analyzed each month for the past two years, and the average heat balance for the two years is shown at the right in the table. To establish an average efficiency of 77.5 per cent for two years is indeed an excellent record. By comparing this heat balance with the one representing the operation under the original conditions the changes that took place in the losses are apparent. The improvement registered merely means better combustion conditions brought about by positive knowledge of what was actually taking place within the combustion chambers.

Converting the improvement shown by the figures into dollars and cents, it represents an annual saving of about $14,200. Evaporation under the original conditions was 12.5 lb. of water per pound of oil burned. The steam cost at that time was 45c. per 1,000 lb., considering the cost of fuel only. With the improvement in operation the evaporation increased to 13.9 lb. of water per pound of oil and a resulting steam cost of 40.5c. per 1,000 pounds.

It is true that the cost of the instrument installation, approximately $3,000, must be considered. But who would not respond to a return of 500 per cent on the capital invested? Although this happens to be an oil-burning plant, the same reasoning may be applied to many coal-burning plants.

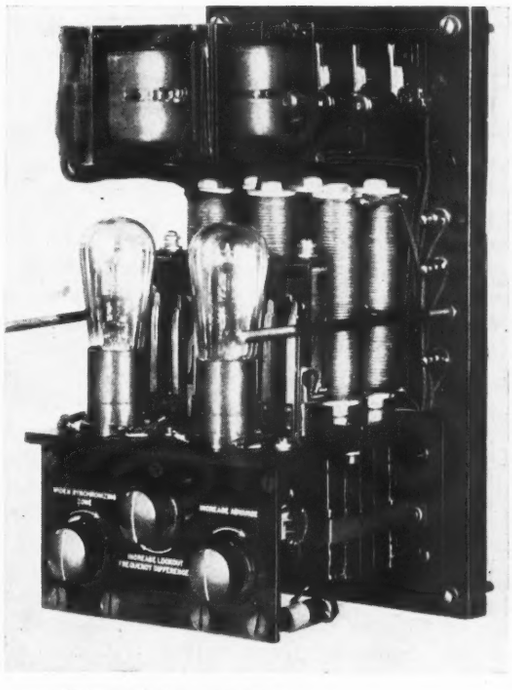
▼ ▼ ▼

Automatic Synchronizer Uses Vacuum Tubes

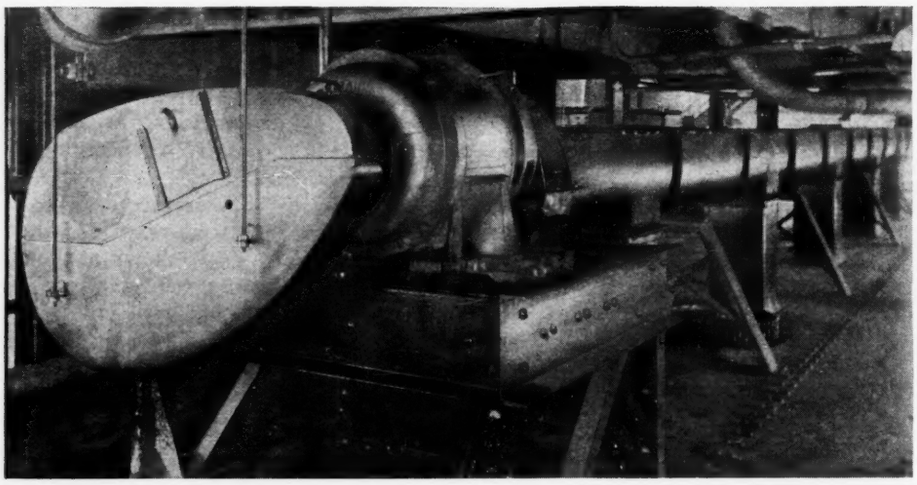
THE DAY'S TENSE MOMENT in the old-time power plant came when the big machines were synchronized, pilot lights going dim and bright, the synchroscope pointer turning slower and slower—an instant of resolve and the switches slamed in! And then—either a protesting grunt from the machines or a sigh of relief from the operator.

All that is gone, and now even the mechanical synchronizers of recent years may be replaced by an automatic vacuum-tube arrangement, recently announced by the Westinghouse Electric & Manufacturing Company. This device has no moving parts, and, requiring but five volt-amperes, can draw its energy from a condenser bushing, an advantage over mechanical synchronizers, which, needing 66 to 150 volt-amperes, must be supplied from potential transformers. The low power consumption of the new synchronizer is partly due to the use of Hipernik in a small transformer embodied in it.

The automatic synchronizer's operation involves current based on the beat frequency between the two circuits which is rectified and used to control the grids of the vacuum tubes. Two simple adjustments are made by radio-type rheostats. One changes the frequency difference at which the device will synchronize (usually 1/6 cycle), the other adjusts the angle of advance to allow the circuit breaker to close at exact synchronism. The synchronizer is twice as accurate as the most skillful human operator.



Vacuum-tube synchronizer with cover removed



Screw-type coal conveyor driven by a 25-hp. fan-cooled full-voltage starting squirrel-cage motor

Full-Voltage Starting Simplifies A.-C. Motor Applications

Squirrel-cage motors have been developed that can be started by connecting them directly to the line and yet maintain the inrush current within N.E.L.A. recommendations. These motors have full-speed characteristics practically as good as those started on reduced voltage, and employ much simpler and less expensive starting equipment

By E. W. HENDERSON
Designing Engineer
Reliance Electric & Engineering Co.

ACROSS-THE-LINE induction motors, as the name implies, are designed to be connected to the power supply circuit without the use of any intermediary apparatus to reduce the voltage during the starting period. The current inrush to these motors is limited largely by the design of the rotor. The principle on which most full-voltage-start motors operate was proposed about the same time by Boucherot and by Dobrowolsky over 40 years ago. The latter, as he himself wrote, considered the circumstance a "rather trivial incident in alternating-current development." Yet in America at least such motors had not been produced in any volume prior to the last five years. Now they are rapidly replacing the older type in ratings up to 50 hp. and bid fair to become the standard motor.

Two main considerations are responsible for the rediscovery of these motors: First, the desirability of limited values of starting currents as proposed by the National Electric Light Association in 1923 and the gradual adoption of them as something of a standard by power companies. Secondly, the economy and simplicity of the starting equipment with its reduced cost of maintenance.

Any induction motor consists of two main parts, the stator and the rotor, the names being descriptive. The stator takes energy from the supply system, produces a magnetic field which links both the stator and rotor windings, and inductively produces currents in the latter, when these windings form a closed circuit. The reaction between this main magnetic field and the rotor current-carrying conductors produces the torque of the motor. There are two main divisions of induction motors, the slip-ring type and the squirrel-cage type. In the former the rotor winding is a facsimile of that on the stator. The winding's terminals are connected to slip rings, and brushes bearing on these rings form the stationary terminals of the rotating winding. The starting current of slip-ring motors is controlled by inserting an external resistance in the rotor circuit.

The squirrel-cage motor has its rotor winding in the form of solid bars, these bars connecting into a common ring at each end of the winding, Fig. 3. On account of its substantial construction and simplicity, it has become the most used general-purpose a.-c. motor.

The full-voltage-start motor has a stator similar to that of the older type of motor, but the rotor has two squirrel-cage windings instead of one, Fig. 4. Such a rotor is popularly known as a double-cage, or a "Boucherot," rotor. The outer squirrel cage is usually a high-resistance winding, while the inner one has a low resistance. The high resistance is obtained by limiting the cross-sectional area of the bars or by making them

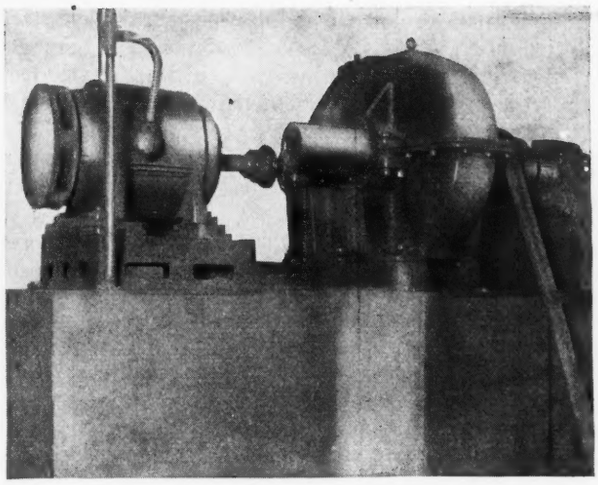


Fig. 1—Fan-cooled full-voltage start, 15-hp. 900-r.p.m. squirrel-cage motor connected to its load through reduction gear

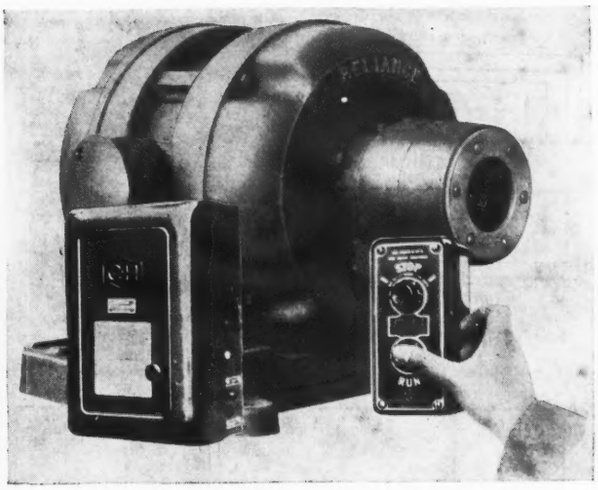


Fig. 2—Full-voltage-start squirrel-cage motor with its magnet-type starter and push button for remote control

of a material having a higher resistance than copper. The inner winding has a low resistance due to its large cross-section. The freedom of choice in the relative resistance and reactance of these two windings makes it possible to have motors of quite varied characteristics.

At the instant of applying voltage to the motor, the frequency of the rotor current is the same as that of the line. The induced current in the inner winding sets up magnetic fields which displace the main magnetic field and makes it link principally with the outer winding. The most of the starting torque is, therefore, produced in this outer, high-resistance winding, Fig. 5. The starting current is limited by this choking effect in the inner winding and by the high resistance of the outer winding, so that the starting torque is exerted with a comparatively low current inrush. As the motor's speed increases the current shifts from the high-resistance to the low-resistance winding automatically, due to the decreasing frequency in the rotor windings, Fig. 6. Under normal load conditions practically all the rotor current flows in the inner winding, and because of its low resistance the rotor's slip is small and the speed close to synchronous. The double-cage rotor thus has two important characteristics, adequate starting torque with low starting current, and low slip at full load and high efficiency.

At no load and at light loads the characteristics of the double-cage motor and those of the normal single-cage motor are practically identical. As the load increases and the current increases in the inner winding of the rotor there is a tendency for this current to distort the main magnetic field and cause part of it to flow above this inner winding, thus producing a more ineffective field distribution and causing a lowered power factor on the motor. To prevent that, a reluctance is introduced into the flux path between the outer and inner rows of bars. The reluctance is generally a narrow slit joining the outer and inner winding slots, Fig. 4. Instead of a narrow slot between the windings, sometimes the two windings are placed very close to one another with only a thin strip of core metal between them. This strip becomes saturated and forms a hindrance to flux flow. By the use of such devices the power factor is made practically as high in a well-designed across-the-line motor as it is in the normal single-cage machine.

The flux between the two layers of windings results in reduced power or torque. For this reason the pull-out torque for a given stator winding may be a little higher with a single-cage than with a double-cage rotor. Inasmuch as across-the-line motors have pull-out torque exceeding 200 per cent of full-load torque, that reduction in torque is no handicap in the ordinary use of such motors.

It is possible to get an action similar to the double-squarrel-cage winding in a single-cage rotor by making its bars narrow and deep. The current, at starting, is forced to the upper part of the conductor, thus reducing its effective area, and the characteristic of increased resistance is obtained. Occasionally, the bar may be made an "L" or inverted "T" shape, but in most cases it is of the rectangular form and made thin and deep. Such rotors are used on the smaller-capacity machines. They may also be used in motors of synchronous speeds of 1,200 r.p.m. and below, even on sizes up to 20 or 25 hp., as it is easier to keep the starting current within required limits on the slower-speed machines than on the high-speed types operating at 1,800 and 3,600 revolutions per minute.

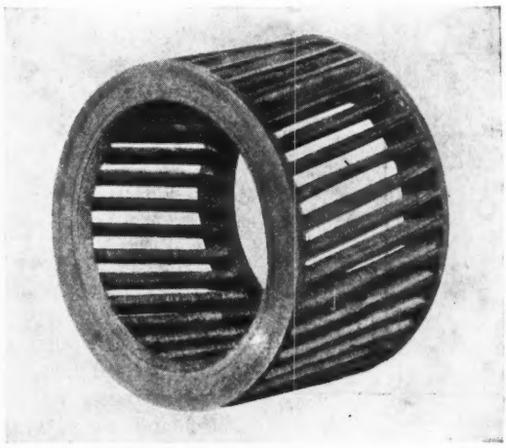


Fig. 3—Single squirrel-cage rotor winding

There are on the market other types of motors with current-limiting rotors, chief of which consist, essentially, of two windings. One winding, by some mechanical contrivance, is made inoperative during the starting period. The motor starts up as a high-torque motor, the other winding coming into service as the motor speeds up.

Across-the-line motors on the market today are of two

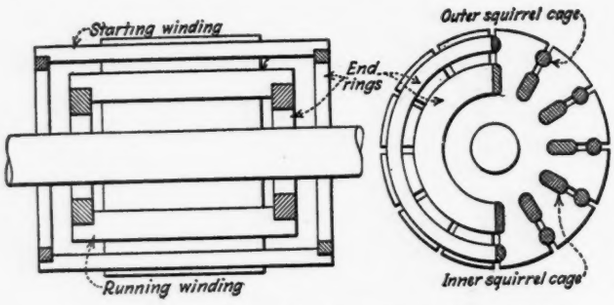


Fig. 4—Section through rotor with double-squirrel-cage winding

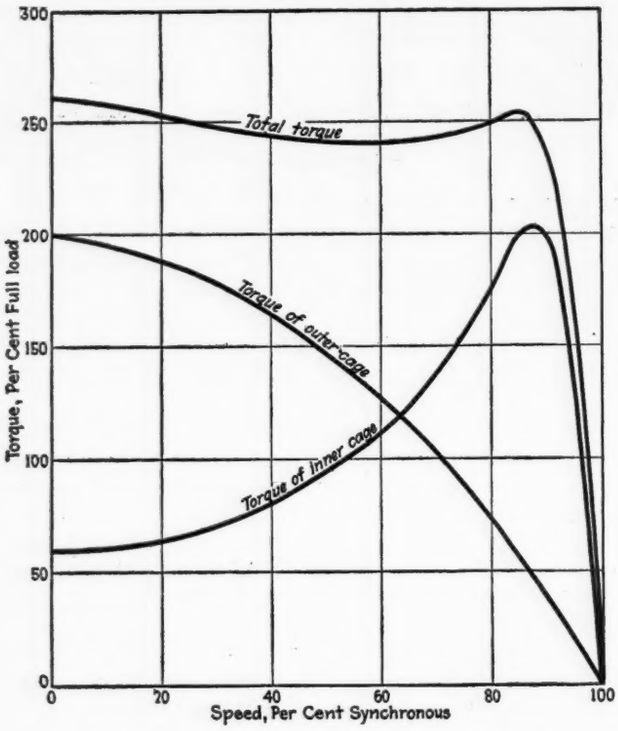


Fig. 5—Speed-torque curves of a double-squirrel-cage winding motor

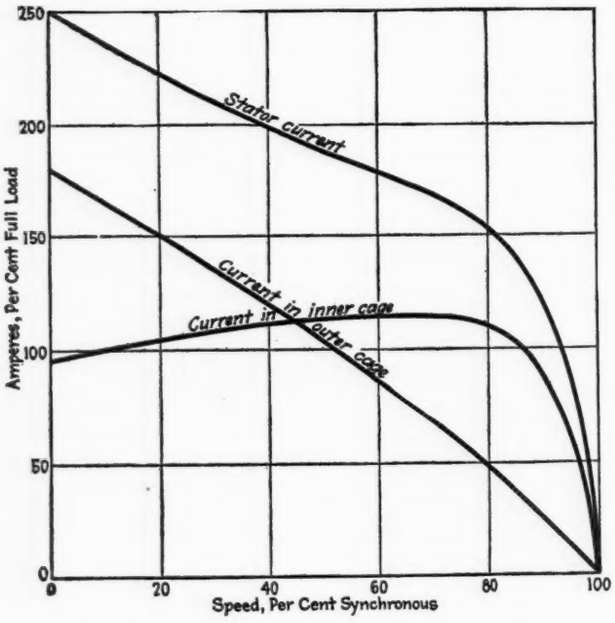


Fig. 6—Current in the two windings of a double-squirrel-cage rotor

classes, normal torque and high torque. Both have starting currents within N.E.L.A. recommended limits and are distinguished principally by their starting torques. The torque curves, Fig. 7, will make this plain. Normal-torque motors have a starting torque averaging 130 to 160 per cent of full-load value. High-torque across-the-line motors have a starting torque varying from 200 to 300 per cent of full-load value.

Normal-torque motors are used for general purposes, such as driving lineshafts, fans, machine tools, etc., and take the place of the older type of motors whose starting requires auto-starters or compensators. These motors need no special care in their application.

On account of the high starting torque of high-torque motors they should be used only where that torque is necessary. Such applications are conveyors and certain types of presses. When connected to their load through belts or chains special care should be taken to insure

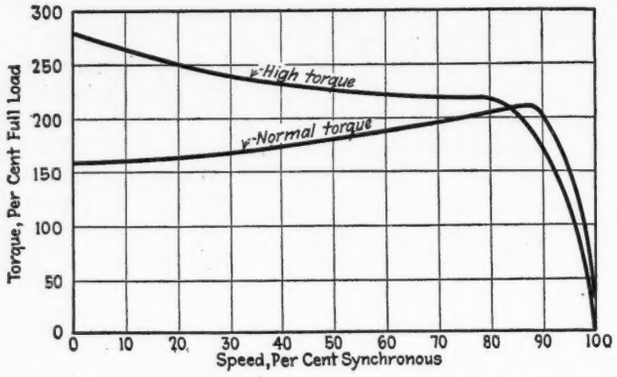
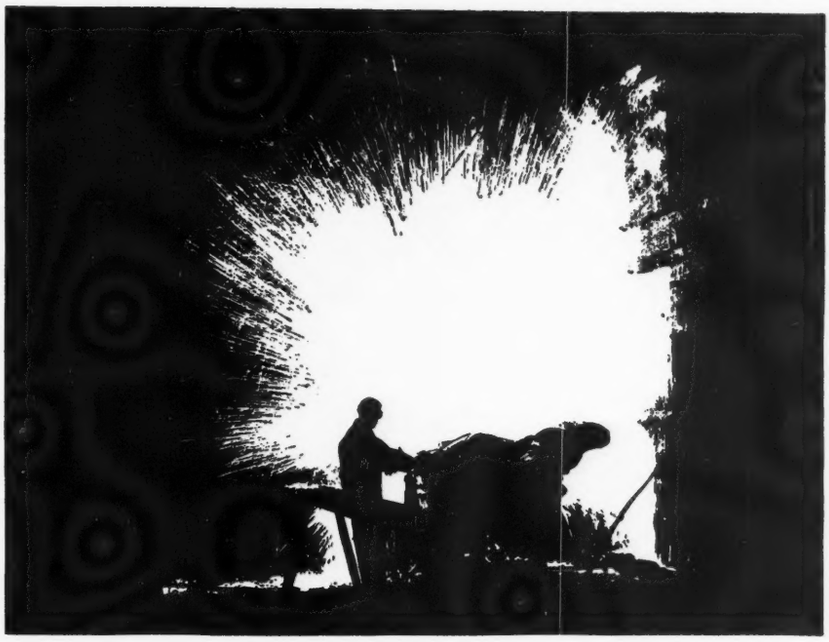


Fig. 7—Torque characteristics of full-voltage-start motors

that these drives are adequate to stand the shock of the high starting torque.

Running characteristics of the full-voltage-start motors are similar to older-type squirrel-cage motors. Efficiencies are about equal, or slightly higher in the across-the-line type. The power factors are slightly lower in the full-voltage-start motors of the larger sizes. The slip of both is low, with the double-cage type having a slight advantage. Maximum output and pull-out torques are ample in both, but inclined to be slightly lower for the across-the-line type. The reduced starting current of the newer type is its chief asset, and it is a real economic value. The older motors require starting apparatus of the auto-starter or other types. This is more expensive, both in first cost and in upkeep, than the starting equipment of the across-the-line machine. The newer motors will cost slightly more than the older type, but the double-cage motor can be supplied with a push-button starter that costs much less than the old manually operated starter. As a result, a saving of from 16 to 32 per cent is possible on the combined cost of motor and starter. Not only is the first cost of the combined outfit lower, but the maintenance of the across-the-line starters is less than that of the older type.

Although squirrel-cage motors of the reduced-starting-current type have formed the main topic of this article, standard single-squirrel-cage motors are also thrown across the line on several private supply systems. Where such practice is allowable, there is little advantage in using an accepted across-the-line type of motor. Care should be taken, when standard motors are used in this way, that the stator coils are braced to withstand the large inrush currents.



"Flashing off" a 14-in. O.D. heavy-wall pipe before the "push-up" which completes the resistance weld

Welding Large-Diameter Heavy-Wall Pipe

THE Babcock & Wilcox Company, at its Barberton, Ohio, works, has made some interesting developments in the welding of large-diameter heavy-wall pipe by the electric-resistance method. Using great pressure and very heavy currents, end-to-end joints have been made with 14-in. seamless steel tubing having a wall thickness of $1\frac{5}{16}$ inches.

This heavy-wall large-diameter pipe is used by this company for headers in high-pressure superheaters and other boiler auxiliaries. By the electric-resistance method of welding standard mill lengths are joined to form sections up to 50 ft. in length as needed in very large boiler units.

Thick-walled 1-in. tubing, similarly welded, is used in making coils for special heaters, as required by various industries for heating liquids under high-pressure and high-temperature conditions.

Many specimens from the completed welds in this heavy-wall pipe have been subjected to bending and tension tests as well as macro- and micro-examination. It is reported that these tests have all shown the welds to be entirely satisfactory. In machining off the excess flash, a reasonable amount is left inside and outside the pipe for reinforcement. This increased cross-section gives assurance that the welded joint is stronger than the pipe itself.

POWER RESEARCH NUMBER, MAY 26

will tell in detail of the efforts to find materials best suited for steam turbine blading. It will present what research has found out about corrosion by flue gas; how it has led to isolating causes of boiler-metal cracking; and advanced the diesel engine through fuel-spray investigations. It will tell of the importance of model testing to hydro projects and will summarize the research activity in welding, lubrication, condensers, and refrigeration Each of these is discussed by authorities on these respective subjects.

In addition there will be tables containing information on over

600 Current Research Projects in the Field of POWER

This number, representing the most comprehensive work of its kind yet undertaken, will provide a useful reference and serve to avoid needless and expensive duplication of effort in research

Test of Diesel Governor for A.-C. Drive

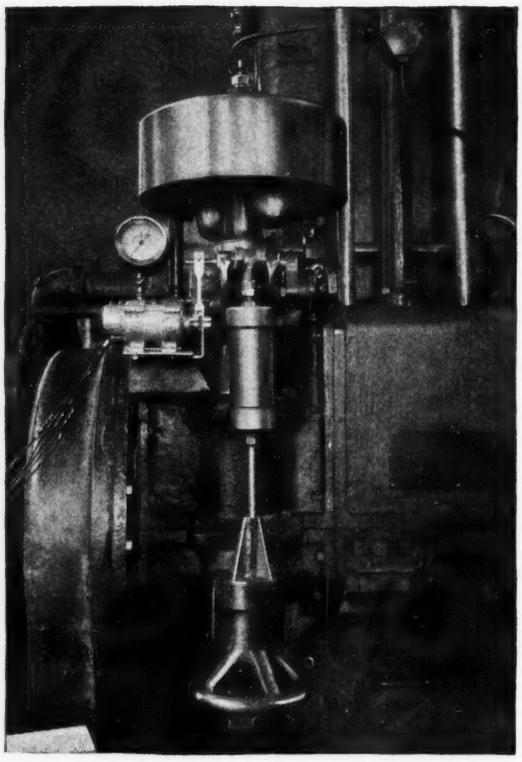


Fig. 1—The diesel governor tested for regulation

By S. LOGAN KERR
and W. M. KAUFFMANN

I. P. Morris & De Lavergne Inc.

FOR SATISFACTORY parallel operation of diesel-driven generators, the no-load to full-load speed variation should be held within definite limits. The response of the engine to fluctuations in demand should be prompt and the momentary speed variation not exceed the inherent variation by a large amount nor last very long.

Research has recently been undertaken by I. P. Morris & De La Vergne, Inc., with a view toward refining their governor design to meet the more exacting requirements of modern generating plants. The experience of the company in designing and building precision governors for hydro-electric units was available and the tests just completed have resulted in securing exceptionally good performances.

A standard, 4-cylinder, 14½x18-in., 277-r.p.m. Type VG De La Vergne diesel was utilized, equipped with a semi-inclosed governor acting directly upon the bypasses of the fuel-injection pumps. A General Electric 217-kva. 3-phase, 60-cycle, 2,300-volt alternator and direct-connected exciter were attached to the engine on the test floor. A water rheostat was constructed and installed in the yard outside the shop, with a 2,300-volt, 3-phase, oil circuit breaker across the lines for opening or closing the main supply from the generator leads. High-tension fuse equipment was employed for protection of the generator and a group of disconnecting switches was installed in case any work was to be done on the electrodes of the water rheostat.

The field rheostat and field switches, together with both alternating- and direct-current metering equipment, were placed on a temporary switchboard, adjacent to the generator, to minimize the amount of wiring and leads. The electrical output of the generator at unity power factor was determined by these instruments, and with generator characteristics and efficiencies known the engine load could be accurately calculated. Load was carefully balanced on the phases, and periodic checks were made to insure that the balancing of the phases was accurately maintained.

The distance between the electrodes was adjustable, and water level and immersion were kept constant. Some salt in solution was necessary to secure the proper resistance. No difficulty was experienced with corrosion of the electrodes. The engine was thoroughly tested and all of the electrical equipment operated under conditions approaching actual service conditions in a normal generating station.

Special instruments, to record with precision the governor performance, included a Westinghouse R. F. frequency recorder having a range from 58 to 62 cycles, giving 0.125 in. on the chart for each 0.1 cycle. The chart speed was increased by special gearing and equipment so that 2 in. on the chart would correspond to 100 sec., instead of one hour as called for on the standard meter. The record gave an exceptionally accurate indication of speed in terms of frequency rather than revolutions. The meter's response on test in the governor research laboratory indicated a lag of 0.05 of a second in recording true speed variations.

A Selsyn transmitter was attached to the governor sleeve fulcrum and a corresponding receiver was placed on the frequency recorder in such a manner that the movement of the governor collar was recorded simultaneously with the frequency and gave an accurate record of the position of the governor weights at all times. This record was of great value in determining the proper governor setting and in recording the performance of the governor with different settings of linkage and other adjustments.

Method of Test

After preliminary tests were made and the apparatus calibrated, the procedure employed was to load the unit by increasing the excitation on the generator, hence increasing variation on the water rheostat. When full load was reached at normal voltage the engine was maintained at its normal speed through the action of the governor and a record of five minutes' duration was taken for each setting. The oil switch was then tripped and all load

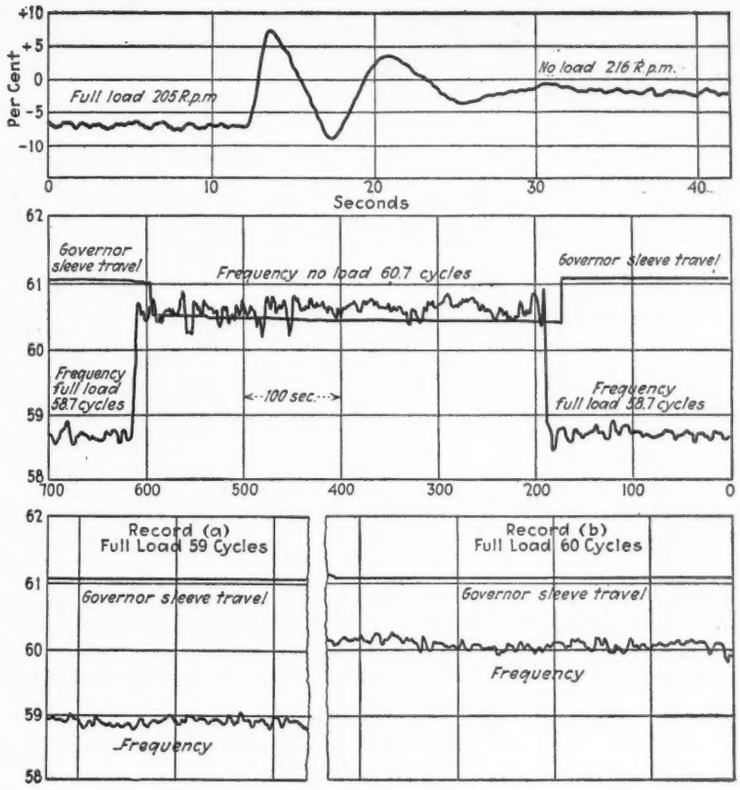


Fig. 2 (Top) Record obtained from an old air-injection diesel, at a sudden reduction of load

Fig. 3 (Center)—Speed variation of governor under test when load is thrown off

Fig. 4 (Bottom)—Fluctuations of speed at steady full load

thrown off suddenly. The record of speeds and position of governor sleeve was secured by the recording instruments. After operating at no load for another five minutes the oil switch was re-closed, throwing full load on the engine, and comparison was made with the previous record at full load. Similar tests for speed variation from full load to half load and half load to no load were recorded.

The sudden application and rejection of loads through the use of an oil switch and fixed electrodes in the water rheostat gave a more severe test of governor performance than would be actually experienced in the field.

The governor, Fig. 1, with semi-inclosed flyballs, is driven through a flexible drive by spiral gears from the engine camshaft. The motion of the bronze flyballs is transmitted to a sliding sleeve which rotates with the governor spindle and moves vertically from lowest position at light load to highest position at overload. This movement, acting through a simple linkage, changes the time of bypass opening of the fuel pumps in accordance with engine load. The flyball fulcrums are bolted to a cast-iron apron machined over-all and dynamically balanced. The governor sleeve floats concentrically on a case-hardened and ground-steel spindle collar, which also supports the main spring.

A strong central spring, or main spring, inside the governor sleeve balances about 85 per cent of the centrifugal force. The initial compression of this spring is set accurately by means of ring shims of $\frac{1}{32}$ to $\frac{1}{8}$ in. thickness.

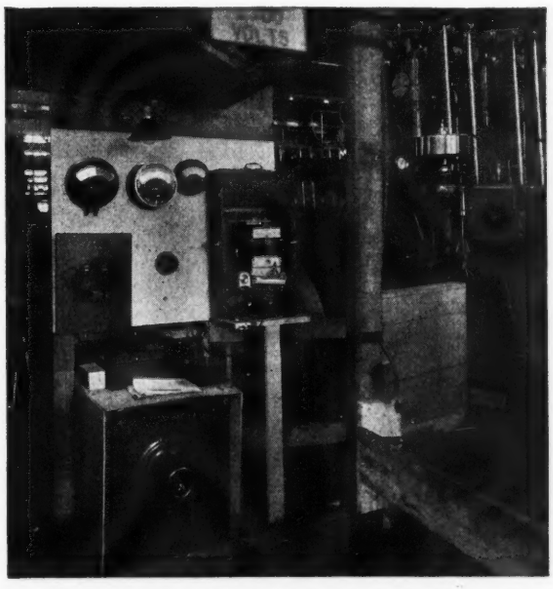


Fig. 5—Arrangement of test equipment

The rest of the centrifugal force is balanced by a speed adjuster, which consists of two springs inclosed in a steel tube casing, and adjusted by hand or by a motor. The compression of these springs acts directly upon the sliding sleeve collar. The speed adjuster permits variations of $\pm$ 0.1 cycle.

Friction is reduced by the use of ball bearings at flyball fulcrums, rollers and governor sleeve collar thrust bearing. Complete lubrication of all moving parts is provided.

Test Results

The results of this work have demonstrated stable governing with a speed variation from no load to full load of 2 cycles, or 3.33 per cent. The fluctuations at steady load were within 0.2 cycle at full load, and 0.3 cycle at no load. The maximum instantaneous variation, going from full load to no load by opening the oil switch, and likewise from no load to full load, was 2.5 cycles.

The graph in Fig. 2 shows a record obtained several years ago of speed variation on a diesel engine at a sudden release of full load. At that time it was considered good performance. It will be noted that the curve shows a sudden surge of about 15 per cent above normal, followed by excessive fluctuations of decreasing amplitude, until a steady condition is reached after a period of approximately 25 sec., at which time the speed was 5 per cent above normal.

A similar record taken with a governor improved as a result of the tests is shown in Fig. 3. No excessive surge appears, and normal conditions are reached almost instantaneously. As indicated by the graphs in Fig. 4, the fluctuations at steady full load are insignificant with either 59- or 60-cycle operation.

The accuracy with which the test records were made permitted the study of the effect of every minute change in spring tension, bypass clearance and arrangement of governor linkage and proved to be an invaluable record upon which to check the governor design.

Natural Gas Proves Best Boiler Fuel

By H. K. BLANNING
Engineer
Armour & Co., Chicago

Natural gas, replacing pulverized petroleum coke, shows 25 per cent reduction in total power plant expense. Relative fuel costs for equal B. t. u. were found to be 100 for natural gas, 118 for petroleum coke and 196 for oil

THE MORRIS & COMPANY packing plant at Oklahoma City is owned and operated by Armour & Company. Situated adjacent to the large oil- and gas-producing districts of Texas and Oklahoma, it occupies a strategic position in filling its fuel requirements. At various times in the past it has been found economical to change from one fuel to another as the local development of resources progressed.

Originally the plant was designed and built to burn Western coal on hand-fired grates. Later a complete pulverizing plant was installed and the furnaces changed to accommodate this fuel. Pulverized coal and later petroleum coke were used. In addition complete oil-burning equipment was installed as stand-by for the pulverized-fuel equipment and to take advantage of price variations in the various fuels. In recent years petroleum coke had been found to be the most economical fuel to use, until the intensive development of the Oklahoma City oil pool made natural gas available at a price that definitely displaced the petroleum coke.

In 1929 negotiations were completed for furnishing natural gas to the plant. This gas is now being delivered from the south Oklahoma City field through a 10-in. line seven miles long. The gas is drawn from an extensive group of oil and gas wells, the open flow of the connected gas wells alone being in excess of a billion cubic feet per day.

From the oil wells residue gas is pumped into the line after the gasoline has been extracted. Output from the gas wells is first run through a high-pressure absorption gasoline plant, where the gasoline is extracted. It is then delivered to the gas distribution system at any pressure required up to, but not in excess of, 350 lb. per square inch.

Tests made over a period of six months show the following natural-gas characteristics at the boiler plant:

	Max.	Min.	Average
Gravity	0.686	0.670	0.676
B.t.u. per cu.ft. gross at 30 in. and 60 deg.	1203	1127	1171
Temperature, deg. F.	88	65	76

Built in 1918, the pulverized-fuel preparation house was one of the pioneer installations of the Southwest and at the time created considerable comment on the then new method of combustion of solid fuels. Its construction was amply justified by the savings made. However, even though the plant was well maintained and operated, the general deterioration of the equipment, owing to its age, had increased maintenance, labor and power costs considerably beyond that considered to be good modern practice. Replacement would have been necessary had not gas become available.

Briefly, the preparation plant consisted of a separate building housing a separately fired drier, two 6-ton mills and various conveyors. The pulverized-fuel furnaces were fired vertically, the fuel and air mixture impinging on an ignition shelf thought to be necessary when the pulverized fuel was first used. The maintenance cost on these furnaces was high because of the high combustion temperature of the petroleum coke coupled with restricted furnace volume and small ratio of water-cooled area to total area of furnace walls. The high furnace temperature caused frequent tube blisters, wall failures and renewals of sprung arches.

The boiler plant consists of five 4,680-sq.ft. and two 3,000-sq.ft. horizontal water-tube boilers operating on natural draft from a tile stack 11 ft. in diameter and 156 ft. high. It has not been found advisable to install economizers. Feed water is treated in an external softener, heated in an open heater and fed to the boilers under control of water-level regulators. The normal steam demand is approximately 90,000 lb. per hour and the annual fuel consumption 25,000 tons of petroleum coke and 4,000 bbl. of fuel oil.

In changing to gas fuel only the first large boilers were altered, the smaller two not being required to carry the load. Fig. 2 shows the revised boiler furnaces with burners in place. It will be noticed that the settings extend over two levels, the boilers being operated from the upper level, with all instruments and controls at that elevation.

The changes involved the elimination of the ignition shelf, substitution of single-suspension arches for sprung arches in the dutch oven furnaces, extension and general enlargement and rebuilding of the furnace walls. The furnace volume was increased from 1,485 to 1,955 cu.ft., or 0.417 cu.ft. per square foot of heating surface, giving a normal heat release at 150 per cent rating and 74 per cent efficiency of 16,200 B.t.u. per cubic foot of furnace volume per hour. The gas burners were placed at the extreme bottom of the furnace to allow maximum time

for mixing to complete combustion before the gases strike the boiler tubes. The furnaces are 15 ft. 11 in. deep under the arch.

The location has justified itself, as actual operation shows that the gas can be burned with low excess air and still show no indication of incomplete combustion as it enters the first pass of the boiler.

Gas burners are of the common natural-draft plate type. No air preheaters were installed, because accelerated combustion with preheated air was not thought necessary with the long flame travel. The combustion air is drawn directly from the basement by natural draft, the amount of air being controlled by dampers over each burner and by the furnace draft as controlled by the uptake damper. Two burners of 84 jets each are provided in each furnace. The gas pressure in the main manifold is normally 8 to 12 ounces.

Gas and Oil Burners Used

Each gas burner is equipped to receive one oil burner, the two oil burners being sufficient to carry the required load without assistance of the gas. The previously installed oil-burning system of tanks, pumps, heater, etc., was retained for stand-by in case of accidental interruption to the gas supply. The oil storage tanks are held to full capacity at all times as reserve to insure continuity of operation. Fuel oil, of 22 to 24 deg. Baumé, is heated to 140 deg. F. before being supplied to the burners.

Gas is delivered to the plant at any required pressure up to 350 lb. at a point approximately 100 ft. from the boiler room. At present the pressure varies between 160 and 190 lb. It is first reduced to 50 lb. pressure, and then measured with an orifice meter, and this measurement is immediately checked by another orifice meter of a capacity of 150,000 cu.ft. per hour. The gas is then reduced to 8 to 12 oz. pressure and delivered to the boiler room header.

All reducing valves and meter orifice plates are piped and valved with suitable bypasses to allow for their being taken out of service for repair and inspection.

The boiler room is served by a 10-in. main line with a 6-in. loop equalizer. Each boiler is served through one 6-in. line branching into two 4-in. pipes, which again divide into two 3-in. feeders entering opposing ends of a burner. Valves are provided to control the flow of gas to each burner for flame equalizing and balancing, and a main valve operated from a pedestal on the operating floor is provided in the main 6-in. line to control the total gas flow to the boiler. An orifice in this line indicates the gas flow to the boiler on an ordinary inclined draft gage having a capacity of 40,400 cu.ft. per hour at 2-in. water differential.

Steam and oil control valves for the steam-atomizing oil burners are extended upward to the operating floor, as are the single handwheel controls for the air dampers on the gas burners. The oil burners are not kept in place in the gas burners when gas is used, but are available within reach for emergency, being so designed that they can be installed in a minute's time by inserting and tightening one hand screw. A gas flame hand lance is used to ignite the burners when firing up a boiler. In addition an asbestos wicking kerosene hand torch is mounted conveniently nearby for use in case of emergency with gas or when oil is used as fuel.

The gas is ignited at the lower level and the burner flame equalized. All subsequent adjustments are then made from the main operating level. Sufficient peep holes are provided at both upper and lower levels in the front and sides of the furnace to make possible the inspection of flame appearance and travel in all parts of the furnace.

Normally a gas pressure of from 3 to 5 in. of water is maintained in the gas burner header at the boiler. A pressure of 5 in. of water will deliver gas sufficient for operation at 175 per cent rating. The maximum gas demand created by the boilers to date is approximately 120,000 cu.ft. per hour.

The front walls of the dutch ovens were built with one relieving arch spreading over the whole width of the wall and supporting the front wall over the burners. The dutch oven single-suspension arches are supported on beams mounted on buckstays anchored on the floor steel, making their support entirely independent of the

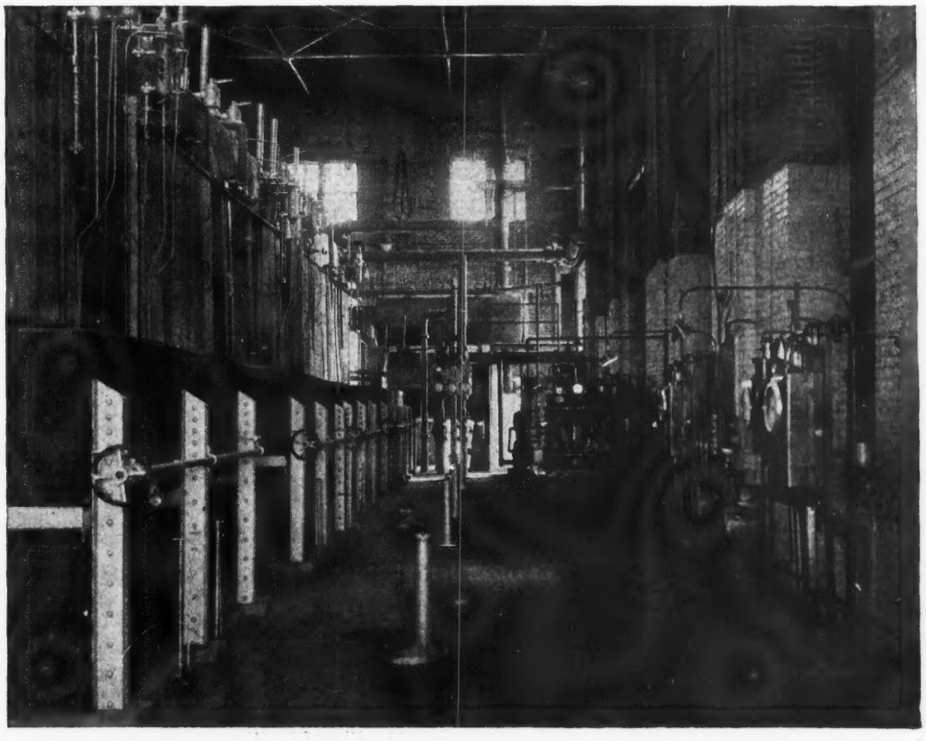


Fig. 1 — Operating floor in boiler room equipped to burn natural gas, or oil as stand-by fuel

side walls. No trouble has developed in the dutch oven brickwork.

In so far as possible, all gas piping connections were welded, in preference to the use of screwed fittings. No cocks are installed in the gas lines. Gate valves are used throughout.

Each boiler is provided with an individual instrument and control board. On it is mounted a CO_2 meter, steam pressure gage, furnace draft gage, gas pressure gage, uptake temperature recorder, steam flow recorder and the uptake damper's adjusting mechanism. The valve controls for gas, oil and atomizing steam are close enough so that the instruments can be read while adjustments are being made.

Average records covering 25 weeks' operation with gas and a similar period while burning petroleum coke show that the stack temperature has been reduced from 546 deg. F. at 120 per cent rating with petroleum coke, to 465 deg. at 132 per cent rating with gas. This is a reduction of 90 deg. F. even with a slight increase in rating.

With gas the percentage of CO_2 in the flue gases varies between 9 and 10 per cent, with an average of 9.5 per cent, indicating approximately 23 per cent excess air, as 11.9 per cent CO_2 is the maximum theoretically possible. The reduction in stack temperature is no doubt caused by maintenance of cleaner heating surfaces, more complete combustion in the furnace and lower excess air. Optical pyrometer readings show furnace temperatures of 2,400 to 2,575 deg. F.

The plant has been operating on gas fuel since early in 1930 and its performance has been entirely satisfactory. Aside from a few minor difficulties, which were quickly adjusted, no trouble has been experienced.

Experiments are now being made with gas-mixing blocks 12 in. thick made up entirely of plastic refractory, to replace the cast-iron blocks. They are built up solid around tin tube forms placed to make each concentric with its single gas jet. To date these blocks have given satisfactory service at a considerably lower cost.

Comparative results with the three fuels may be of interest. Petroleum coke is of a porous and friable structure and easily pulverized and dried, but the age of the plant, with attendant deterioration, made preparation costs high. The plant was operated ten hours per day and required five men besides three coal unloaders.

With the petroleum coke averaging 15,100 B.t.u. per pound as received, the present relative values of petroleum coke, oil and natural gas in Oklahoma City are approximately as follows (not considering relative efficiencies possible):

	Heat Value for Equal Cost, Per Cent	Cost for Equal B.t.u., Per Cent
Oil	52	196
Petroleum coke	85	118
Natural gas	100	100

The gas equivalent to one ton of coke is 25,800 cubic feet. The oil is used only for emergency, as it is more economical to use this fuel than to start up the fuel preparation house.

Estimated on performance to date, the total annual gas consumption of the plant will be between 600,000,000 and 700,000,000 cu.ft., of which about 2½ per cent will be used in killing-plant operations, the balance being burned under the boilers.

Power Expenses Reduced 25 Per Cent

Estimated savings by the use of natural gas have been exceeded. A study of cost of operation during the period since the plant was placed fully on gas fuel shows a reduction in total power plant expenses of 25 per cent. This saving is made up of the items of fuel, labor, supplies, tools and implements, and domestic gas used in killing-plant operations. Total cost of the changeover will be returned in less than two years. Of the savings in cost of fuel for steam, the increase in boiler efficiency owing to furnace changes and better control facilities accounts for 42 per cent, and the balance, 58 per cent, is the result of decreased cost of fuel per heat unit.

In redesigning the furnaces and furnace control equipment, considerable thought was given to possible future developments in the local fuel situation and to modern boiler furnace practice and operation. The furnaces are laid out in such a way that should solid fuels become competitive in price with gas, they may be adapted to that fuel at a minimum of expense. Oil can be burned at any time with no changes in the furnaces. Prior to changing to gas fuel a study was made of economies that could be effected by complete modernization of the pulverized fuel preparation and firing apparatus, and with the results of this study available ready comparison of all available fuels can be made.

It is expected that as the plant operators become more familiar with operation using gas fuel, even better economies will be secured. In addition to the tangible savings resulting there are other smaller intangible benefits, such as extreme ease in operation, cleanliness, and the simplicity of securing data to determine boiler operating economy and establishing proper operating procedure.

The plant is equipped with all necessary apparatus to test the gas. A Junkers calorimeter, gas-gravity balance, gas-analysis apparatus and a continuous gas sample-collecting tank are provided, and a complete test of the gas is made weekly. This practice also is being followed in all other plants of Armour & Company where gas is used.

The author wishes to acknowledge the assistance of F. H. Mugg, of the Industrial Gas Company, of Oklahoma City, who furnished data relative to the gas field and pipe lines.

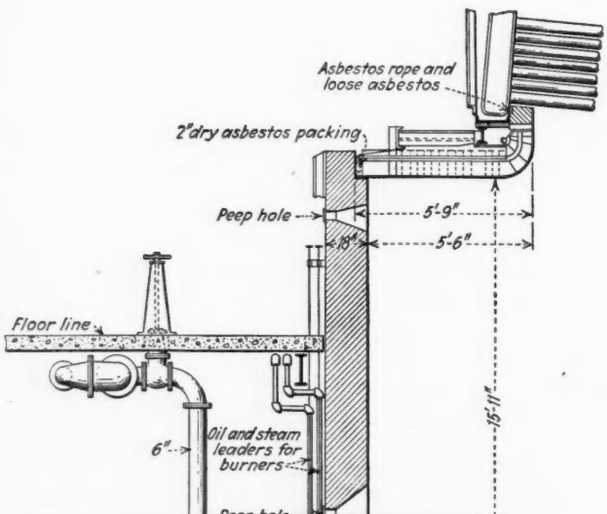


Fig. 2—Furnace as redesigned for natural gas and oil

Hot Water and Cold Air From a Refrigerating System

By B. F. RANDEL

FOR SOME TIME the writer has been figuring along lines of saving heat in connection with refrigerating-machine installations. It has always seemed a needless waste to remove heat from a cold storage plant or ice-making establishment and simply throw it out into the atmosphere.

Whenever I see this heat wasted, I wonder if it would not be possible to employ the principle of the Lord Kelvin heat engine to transform this wasted heat and apply it to some useful purpose, and it has been encouraging to read of attempts made in Italy by Professor Guaranini to employ this heat engine, that is, to use a refrigerating machine for heating purposes.

Some time ago, the principle of the heat engine, or heat pump, was put into practical use in an installation in which the writer is interested. In order to save the condensing water, which in this town is rather expensive, from a 20-ton refrigerating machine it was proposed to install a cooling tower. Fortunately, a proper place for this tower could not be found, so the problem was solved by storing the water in a tank, to be used as needed by a laundry in the vicinity. Every drop is used in this laundry and the heat removed at a low temperature from cold storage rooms and ice-making is transferred to the stored water. Twenty tons of refrigeration makes over 4,000 B.t.u. available per minute, which is quite a saving.

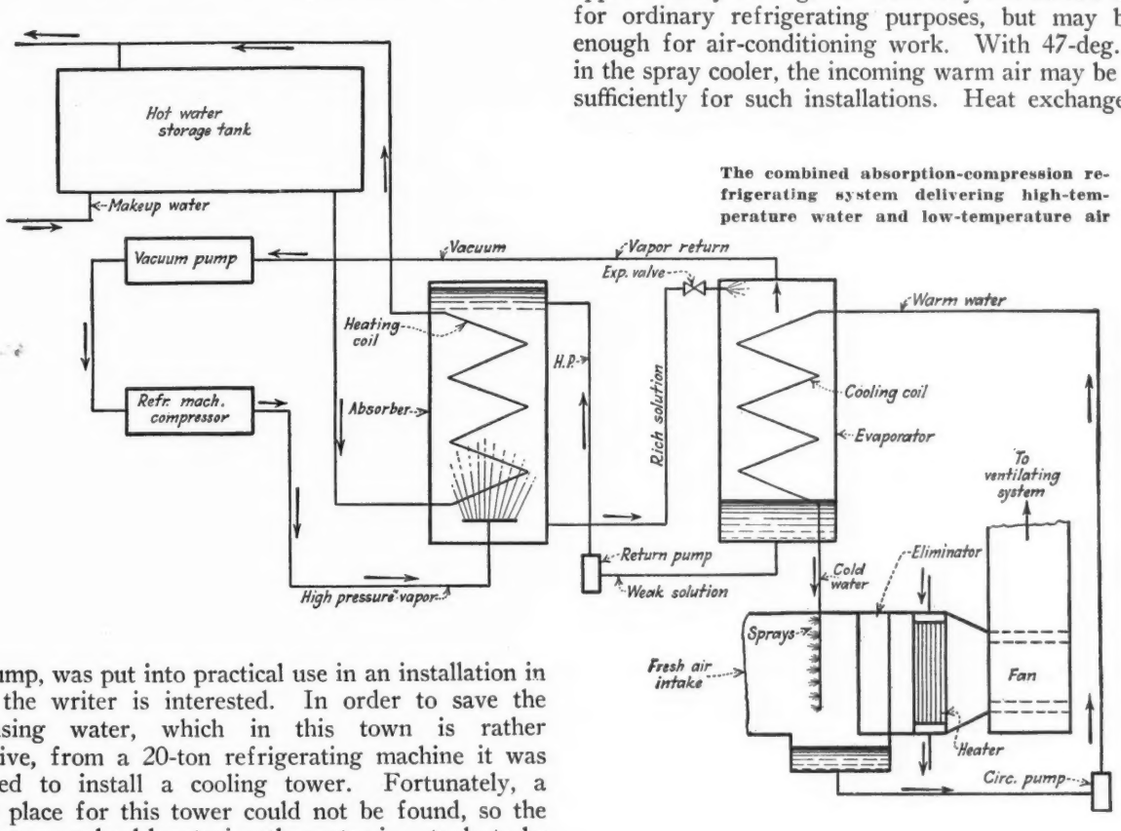
In this case, of course, the advantage is that all the condensing water is used for other purposes, even though this water must be heated from 85 deg., the average temperature after leaving condenser. In other installations, there may not be any use for large quantities of 85-deg. water, and this temperature is hardly high enough for heating purposes, but if this temperature could be raised to say 150 deg., smaller quantities of cooling water would be required, and the temperature would be better suited for domestic purposes or even for heating.

The writer has for some time had a plan under consideration which may be applicable. The illustration shows in a diagrammatic form the proposed arrangement.

A conventional ammonia compressor is used as a refrigerating machine. Now, instead of condensing the ammonia gas in a condenser, the gas is led through water in an absorber and under high pressure. The gas is then liberated out of the solution in another vessel, or evaporator, under a vacuum.

If we assume ammonia vapor at 180 lb. abs. pressure, absorbed in water, approximately 800 B.t.u. of heat will be generated per pound of gas at a temperature of approximately 165 deg. F. by the heat of reaction, and the concentration will be approximately 48 per cent. With an assumed temperature drop of 10 deg., it should be possible to heat the cooling water to 155 deg. in this high-pressure absorber.

Then again by maintaining a vacuum of 10 in., or say, 10 lb. abs., in an evaporator and a drop in concentration to 40 per cent, the corresponding temperature will be approximately 37 deg. F. This may not be low enough for ordinary refrigerating purposes, but may be low enough for air-conditioning work. With 47-deg. water in the spray cooler, the incoming warm air may be cooled sufficiently for such installations. Heat exchangers between rich and weak solutions should of course be installed.



The combined absorption-compression refrigerating system delivering high-temperature water and low-temperature air

To lessen the work on the compressor, there is included a vacuum pump to draw the low-pressure gas from the evaporator and deliver it at ordinary suction pressure to the compressor.

Now the advantages of this arrangement are: The saving of heat, in that the heat removed from the warm air is transferred to the water at sufficiently high temperature for domestic purposes; and the recirculation of air will not be necessary, as with a steady demand for hot water we may consider this need a primary object of the refrigerating machine and the cooling a secondary object, or a byproduct of heating water. The warmer the incoming air, of course, the less will be the load on the apparatus as a heat engine.

Philip Carey Plant Starts Operation

Personal Impressions of the First 1,800-Lb. Plant

By A. D. BLAKE
Managing Editor, POWER

OVER TWO YEARS ago engineers were astounded by the announcement that the new power plant of the Philip Carey Company at Lockland, Ohio, would employ a steam pressure of 1,840 lb. and a temperature of 820 deg. F. Since then the completion of the plant and publication of its details has been keenly awaited.

Now the plant is in operation. It was put in service on May 3 under one-third the works load and with the expectation of gradually taking on the entire load in the course of another week or ten days, thus affording opportunity to make such adjustments as may be necessary.

Not only is this the highest pressure yet employed commercially in this country, but the plant is the largest in any country to employ such a pressure. The pressure is equaled or exceeded by a few European installations, but they are of smaller capacity.

Credit for this pioneer step belongs to W. E. S. Dyer, of Philadelphia, the consulting engineer, steadfastly supported by George D. Crabbs, president of the Philip Carey Company.

The writer was privileged to visit the plant on the second day of its operation and was impressed most by the departure from conventional design. This applies not merely to the use of reciprocating engines instead of turbines as prime movers and reciprocating feed pumps, but to equipment all along the line and to innumerable details of design which were necessary to meet the special conditions. Yet despite these innovations the initial cost has been low, including a complete set of spare parts for all foreign-built equipment.

Decision to employ 1,840 lb. was not dictated by a desire to surpass other pressures in use, but because it appeared to offer the best thermal solution considering the load and local heat-balance conditions. In fact, preliminary calculations considered much lower pressures, but physical dimensions and performance fixed the higher value.

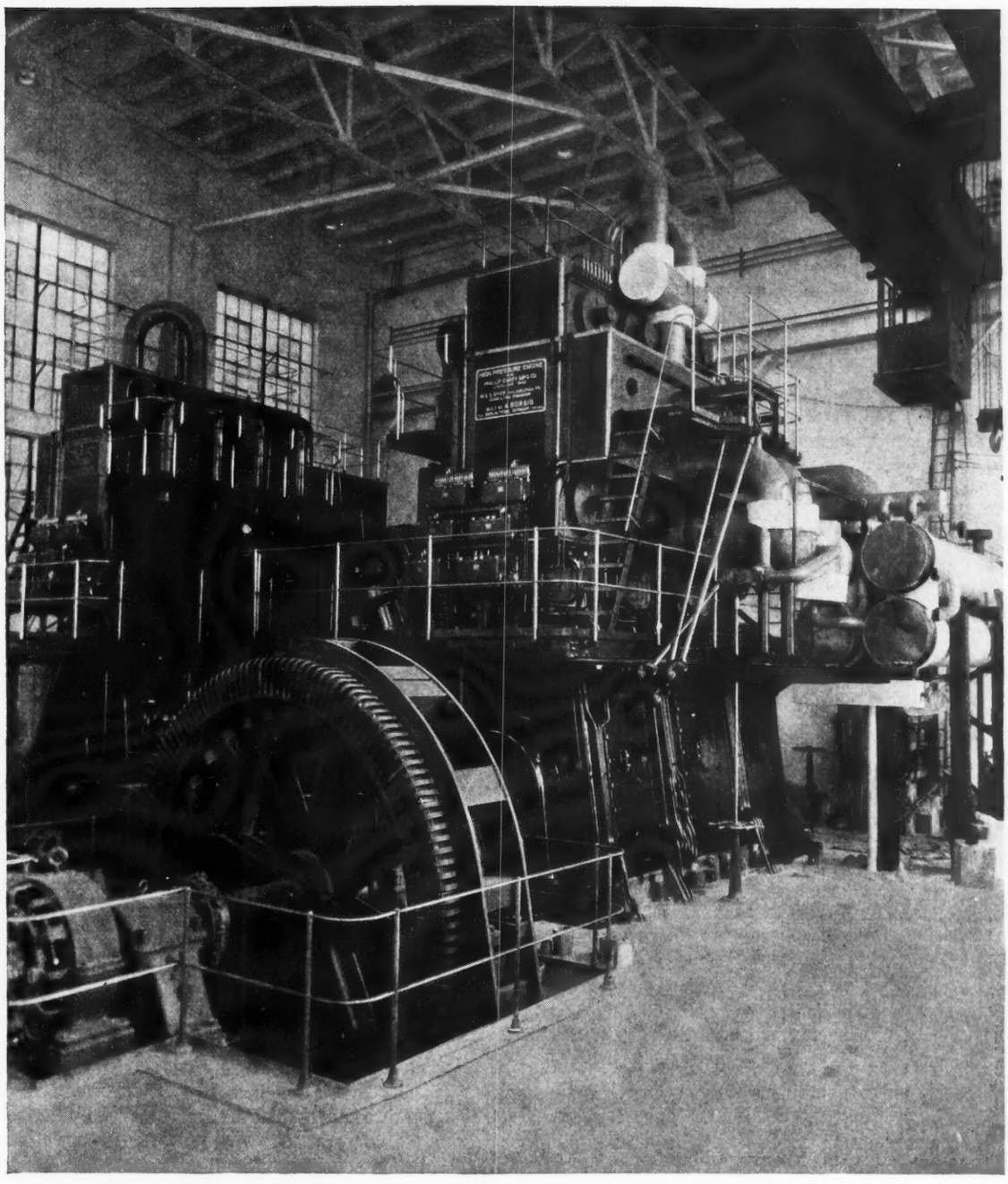
Steam engines were chosen because of their better efficiency in this high-pressure range. Moreover, they cost less and showed a much lower guaranteed water rate than any of the turbines offered.

No attempt will be made at this writing to describe the plant in detail nor its numerous unique features, as these will be covered in several articles to appear in *Power* shortly. Instead, a few first-hand impressions will be given.

While the visitor in roaming through the plant finds many things of unusual interest, the engines themselves command first attention. Of course, they are large compared with turbines of equal capacity, but they are quite unlike the big cumbersome reciprocating units of comparable capacity that reached their zenith in central station practice twenty-five or thirty years ago. The present engines, each of 6060 hp., are high speed, 225 r.p.m., and very compact, considering that they are triple-expansion units. They have no flywheels, as sufficient flywheel effect has been incorporated in the generators, which are 4,700-kva., 2,300-volt machines. The workmanship is excellent and does credit to the European engine builder. Each unit has two vertical single-acting high-pressure cylinders with pistons in tandem with, and opposed to, two single-acting intermediate-pressure pistons. The low-pressure cylinder is double-acting. The cylinder diameters are, respectively, $14\frac{1}{4}$, $21\frac{1}{4}$ and $25\frac{5}{8}$ in. and the stroke 25 in. Live steam reheaters are mounted beside the engine cylinders and reheat the steam between the intermediate and low-pressure cylinders. Piston valves are used throughout, with a specially designed valve motion, and departures from conventional design are noted in the main bearings and connecting-rod ends to conserve space and handle the large loads involved. Forced lubrication is employed throughout, and the crankcase is inclosed.

One is also impressed by the small size of steam piping and the relatively small number of valves. The main steam line to the engines is only five inches inside diameter, and a most unusual form of covering for joints has been adopted. These will be described fully in the later articles.

Despite its many special features the plant appears much simpler than the average high-pressure central station. In many respects it is a "show" plant. Light and accessibility have been kept foremost and generous use of aluminum paint adds to the attractiveness. The boiler room is well laid out; an elevator leads to each of the six boiler room levels, full floor gratings permitting access to all parts and allowing maximum penetration of overhead light. Although the large reciprocating pumps appear cumbersome to one accustomed to the usual centrifugal pumps in high-pressure plants, there was apparently good reason for employing the reciprocating type, as will be discussed later.



Each of these units is rated at 6,060 hp. and drives a 4,700-kva. generator. Note the steam reheaters at the right

Each of the two boilers is rated at 150,000 lb. of steam per hour. They are of special design and have 40-in. forged drums having a thickness of 5 in. Both economizers and tubular-type air heaters are provided, and four pulverizers serve each boiler through tangential burners, two in each corner of the furnace. Bare water walls surround the furnaces, which have dry bottoms of stepped design to facilitate disposal of the ash, which is sluiced from a trough at the rear of the boilers. Exhaust from the engines at 60 lb. goes to evaporators which supply process steam to the works. From the evaporators the condensate passes to special type oil separators, where a constant check is maintained to insure that no oil passes along with the condensate into the boiler feed.

From the boiler-feed tank the water is first handled by small centrifugal pumps which boost the pressure to 60 lb. in order to avoid flashing on the suction side of the reciprocating feed pumps. A deaërating type of feedwater heater is employed.

At this writing it would be futile to make any predictions. The plant got off to a good start with no more than the usual minor adjustments incidental to the starting-up period of any station. When it has been tuned up and has been in operation under load a sufficient length of time a complete test will be made and the results will be available.

The writer wishes to acknowledge the courtesy of Mr. Dyer and Mr. Crabbs in extending an invitation to visit the plant during its starting-up period.

Pumped-Storage Hydro Plant Has Highest-Head Reaction Turbines

THERE is under construction in Germany on the Eder River, near Hemfurth, a pumped-storage hydro-electric plant that will have the highest head francis-type turbines in the world. The development that culminated in the installation of the pumped-storage plant began twenty years ago when work was started on the Eder Valley Dam to regulate the flow of the Weser River for navigation purposes. This dam formed a reservoir of 1,650,000 arce-ft., the largest in Germany.

A power house, Hemfurth No. 1, Fig. 1, was erected at the dam to operate under a head of 55 to 135 ft. Later a second plant, Hemfurth No. 2, was installed at the dam, which is a combination pumped-storage and

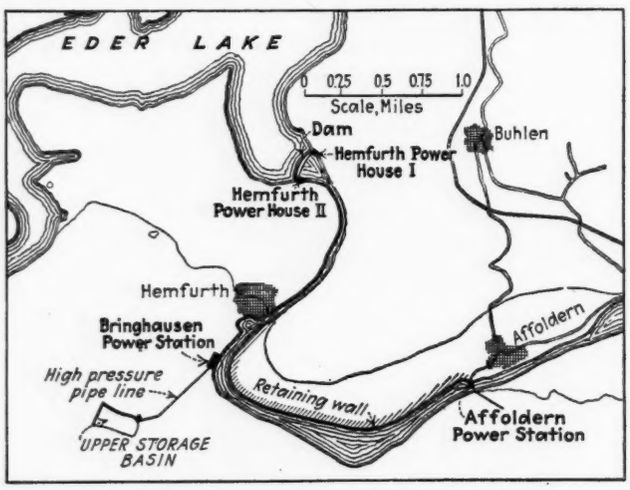


Fig. 1—Location of the power stations at and near the Eder Valley dam

power-generating station. Since the reservoir is to regulate the flow of the Weser River, the new plant made necessary the construction of a larger equalizing reservoir below the dam. This reservoir, built in 1928, was designed of sufficient size to provide for another pumped-storage plant of 115,000-kw. capacity.

Below the dam at Eder Lake the river runs in a deep canyon, and was used for part of the equalizing reservoir. Below the canyon it was necessary to construct an earth embankment about 2¼ miles to a dam and power plant at Affoldern. The head on the single unit in this plant is 30 ft. and its normal capacity is 2,500 kilowatts.

This equalizing reservoir will provide the water for the Bringhauser pumped-storage station now being erected about half-way between Hemfurth and Affoldern plants. At this point conditions are unusually favorable for the construction of a pumped-storage station. The reservoir is formed by a dam at ends of a valley 1,000 ft. above the equalizing reservoir. This reservoir has a capacity of 26,800,000 cu.ft., sufficient to generate 500,000 kw.-hr., and justifies a 115,000-kw. installation.

If in the future more reservoir capacity is necessary another site is available, about 500 ft. away from the present one, where a second reservoir may be created of about the same capacity of the one being built. Construction of this reservoir will provide water to generate about 1,000,000 kw.-hr. per day. It will also be possible to use the excess power from steam and other water-power plants on the system, over Sundays, for pumping.

The Bringhausen reservoir cost less than 25 per cent of the total investment. This item is usually 40 to 60 per cent of the total cost. From the reservoir two penstocks run down the mountain to the power house on the shore of the equalizing basin. These penstocks are about 3,250 ft. long, 8 ft. 6 in. in diameter at the top end and 7 ft. 3 in. at the bottom end. They are supported by nine concrete anchor blocks located at the points where the pipe lines change their angle of incline.

There will be four horizontal-shaft units in the power house, each consisting of a 36,000 kva., 0.80 power factor, 10,500-volt, 50-cycle electrical machine that is capable of delivering this rating as a generator. Each electrical machine is coupled to a 40,500-hp. francis-type wheel designed to operate under a 975-ft. head at 500 r.p.m. The maximum head is 1,000 ft., the highest head for which a reaction wheel has been designed.

On the electric machine's shaft, opposite the waterwheel, a 100,000-g.p.m. pump is connected through a hydraulic-type clutch. These pumps are designed for 1,000-ft. head, which is the highest of any storage pumps in Germany, and each will require the electric machine to develop 29,000 hp. when driving them. When the waterwheel is driving the generator the pump is disconnected, but when the electric machine drives the pump the waterwheel remains connected. Air pressure will be maintained in the turbine casing under the latter conditions to insure that it will be free of water.

This plant is being built to supply the peak load on the power system of the Preussische Elektrizitäts A. G. in the northwestern section of Germany. The project was designed and is being constructed by Siemens-Schuckert, A. G. Berlin, Germany.

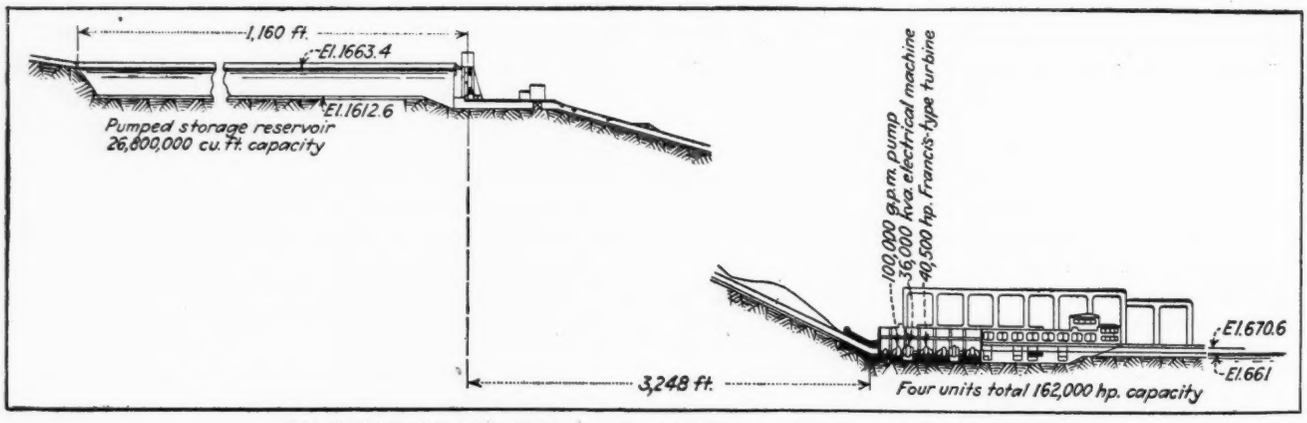


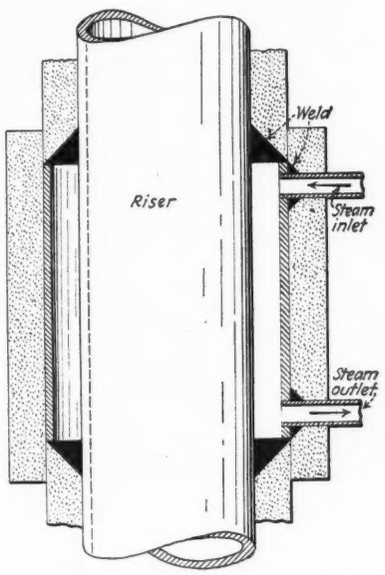
Fig. 2—Elevation of Bringhausen pumped storage reservoir and power house

...RIGHT OUT OF THE PLANT...

Steam Heater for Exposed Tanks

THE accompanying illustration shows an inexpensive heater for exposed tanks of liquids subject to freezing in extreme weather. A piece of pipe two sizes larger than the riser is welded to the riser, forming a steam chamber around it. If the riser is already installed the larger pipe will have to be in two segments and additional side-welding applied.

This heater should be well insulated and placed as close to the tank as practicable and should be of such size as



Steam chamber around riser keeps water above freezing temperature

to heat the water sufficiently to keep it from freezing only. If the heater is made too large, excessive expansion may be set up, and unless adequate provision for expansion is provided damage may result. When figuring the size of the heater it is essential that the tank material be considered, as an error there will result in an ineffective heater.

WILLIAM ANDERSON.

Brooklyn, N. Y.

More About Spray Nozzle Distribution For Cooling Towers

USE OF SPRAY NOZZLES to increase the capacity of cooling towers, as discussed by the writer some months ago, was not intended to be controversial but merely to point out that when additional cooling is desired it can frequently be most economically obtained by adding a pressure header equipped with high-efficiency non-clogging spray nozzles. No engineering analysis of the various factors was given in the article, although such analysis is obviously necessary in any given case to determine whether the cost of the change will be offset by the higher efficiency of the tower within the desired period of time.

In a letter entitled "More Cooling Tower Data Needed," in the Jan. 13 number, E. Burnhorn makes a number of assumptions, mentions factors tending to offset the increased cooling and states that the original article would not be much help to anyone with a cooling tower problem. Perhaps Mr. Burnhorn will undertake to state briefly the various laws governing natural-draft cooling so that anyone having a cooling tower problem can solve it himself. I suggest that one with such a problem would do well to call in a cooling tower expert if he does not happen to be one himself. If that expert happens to be familiar with the many advantages of high-efficiency non-clogging spray nozzles for distribution and initial cooling of water, he will be able to solve many problems to better advantage. A few brief facts regarding this application of nozzles may be of interest.

1. Such spray distribution was first applied extensively to old atmospheric towers where additional cooling was desired. The cost frequently is one-third or less of the cost of building additional tower for the same cooling. If the tower is already highly efficient and delivering cold enough water the change will not be justified. However, the majority of natural-draft towers are operating on yearly average cooling efficiencies not exceeding 70 per cent. And any such tower will be improved by spray nozzles, although the operating and investment costs must be balanced against the value of the colder water.

2. Spray distribution is today being supplied on natural-draft towers by an increasing number of manufacturers who have realized its value. A number of large operators who have tried it will consider nothing else on new towers.

3. With high-efficiency non-clogging nozzles the normal pressure used for work of this kind is 4 to 5 lb. per square inch.

4. As compared with trough or splash systems, well-designed spray distribution gives improved break-up and distribution of water and increases air circulation, particularly during the periods of low wind velocity, when atmospheric towers are at a disadvantage. The jet

action of the nozzles creates air circulation and explains why the addition of nozzles in many actual cases has improved cooling efficiencies from 15 to 100 per cent.

Long Beach, Calif. M. C. COCKSHOTT.

Misplaced I-Beams in a Boiler Setting

BEING ENGAGED in the boiler-setting business, I was recently called in to inspect the center wall between the furnaces of two 1,500-sq.ft. horizontal return-tubular boilers which had buckled badly. When my crew removed a few bricks, a large section of the center wall collapsed, including both firebrick lining and the common brick core.

The collapse of the wall disclosed an unusual condition. The boilers were suspended from a steel frame at both the front and rear lugs. The frame consisted of 12-in. I-beams as uprights and crosspieces of two 10-in. channels parallel with spacers. Each span of channel-irons was supported at the center by an upright 12-in. I-beam. These I-beams were embedded in the center wall between the two furnaces. The center wall in the firebox was 32 in. thick, consisting of 14 in. of common brick as a core, with a 9-in. firebrick wall on each side of the core. The thickness of the wall in the combustion chamber was 23 in. and consisted of the 14-in. common brick core with 4½ in. of firebrick on each side.

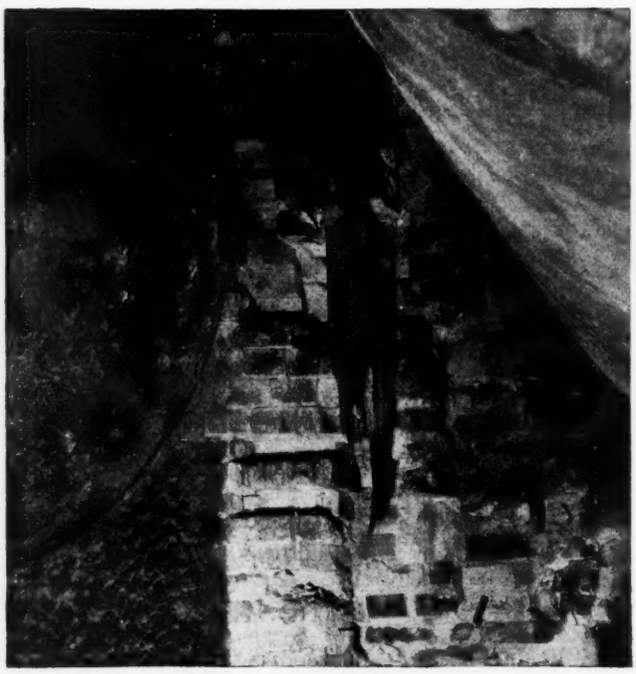


Fig. 1—Front center supporting I-beam burned off

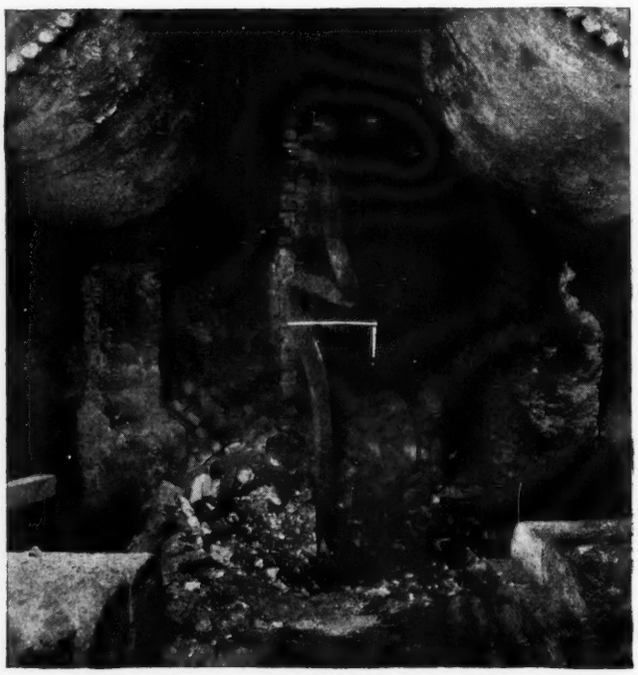


Fig. 2—Shows buckled beam in the center wall

After removal of the center wall photographs of the beams were taken. Fig. 1 shows the beam supporting the front span. This beam had burned away entirely. The beam in the combustion chamber buckled as shown on Fig. 2. This beam was straight originally and rested on a cast-iron plate embedded in the concrete foundation. The top was riveted to the channel-iron crosspieces.

It is my belief that when the upright beam became heated it expanded and buckled slightly. Upon contraction, it no longer rested on the cast-iron plate, and mortar and pieces of brick wedged themselves in the opening. Again being heated, it buckled more, and contraction left a larger gap at the lower end, which filled up with débris. This cycle was repeated until the bottom of the beam was 21 in. above its original seat and the beam assumed the shape shown in Fig. 2. The rule shown in the photograph disclosed that the S-bend is approximately 18 in. wide. This was sufficient to tear the entire wall apart, and it had to be rebuilt.

From these photographs it is apparent that the use of supporting beams in a center wall between boiler furnaces is poor practice. Where boilers are suspended the crosspieces should be of sufficient strength to carry the load without support in the center. If for any reason it is deemed advisable to support the span in the center it would appear to be better practice to carry the brickwork up to a height that will support the span without the use of beams, which was done in this case when the beams were removed.

I have encountered several places recently where beams to support the span were erected and embedded in the center wall. It is hoped that the experience related here will show the futility of this method of construction.

Trenton, N. J. G. M. GALVIN.

Crankshaft Deflection

I NOTICE A QUESTION and answer in *Power* of March 24 dealing with crankshaft deflection. Measuring the distance between the crank webs is a good guide to a crankshaft's alignment. The permissible difference between the readings depends on the size of the crankshaft. For shafts up to 6 in. in diameter a difference between the readings of 0.002-in.; from 6 to 8 in., 0.003 in., and from 8 to 11 in., 0.004-in. deflection is not dangerous. In practice, a small amount of spring is unavoidable, and is not objectionable if kept within the limits named.

Herts, England. W. E. WARNER.

Different Ways of Joining Piston Packing Rings

THE SIMPLEST FORM OF SNAP-RING JOINT is formed by sawing the ring either straight or diagonally across. The ring being filed and scraped to a sliding fit in the piston groove, and the ends recessed to incircle a brass dowel secured in the bottom of the groove, as shown in Fig. 1, the piston is effectively sealed against leakage. But as the ring becomes reduced by wear against the cylinder wall, and its ends spring apart, some blowing of steam around the dowel and beneath the ring is bound to occur. The doweled joint should be located at the lowest point in the circumference of a horizontal piston. The dowel prevents the ring from turning and shifting the joint to the upper arc of the circumference, where leakage is more likely to occur.

Another device for closing the joint formed by sawing a snap-ring either obliquely or straight across is shown in Fig. 2. This method has been used but little. The tongue and palm are cast in one piece and may be made of cast iron, but a tough grade of brass is preferable. As the ring wears away and the ends spring apart, the palm opposes leakage beneath the ring.

A device that has been used to some extent for closing oblique joints is shown in Fig. 3. A bronze plug with a coiled spring beneath its inner end is sunk in a hole drilled in the bottom of the piston groove. The ring joint is set in a channel cut in the outer end of the plug. This channel has a depth just equal to the thickness of the ring ends and its sides are fitted closely. Thus the plug presents an obstacle to leakage either through the joint or beneath the ring. To keep the ring from turning, the ends resting on the plug are filed down about $\frac{1}{8}$ in. to form shoulders abutting the ring's circumference.

Snap rings often are jointed by lapping the ends as shown in Fig. 4. To make this joint entirely effective it is necessary to seal it with a brass plate fastened on inside the ring and covering both of the lateral openings. Otherwise, as the ring wears down and the ends recede from contact with each other, steam will blow through beneath the ring.

Instead of the coverplate being fastened with screws, it may be sprung out against the joint as shown in Fig. 5. In this case the ring is kept from turning, and so shifting the joint from its bearing on the coverplate, by a small boss protruding from the contact surface of the plate and entering a shallow hole drilled in the ring, as indicated in the illustration.

If the difference between the diameter of the uncut snap ring and that of the cylinder will not permit a sufficient length of metal to be filed from each end of the ring to form the lap, then the sides of the ring must first be matched, as at *A* and *B* in Fig. 6, and an opening sawed between the notches along the dotted lines indicated in the sketch. Suppose, for example, the lap is to be $\frac{3}{4}$ in. and the circumference of the ring can be shortened only $\frac{1}{2}$ in., then each of the notches *A* and *B* should measure $\frac{1}{2}$ in. from end to end, while the segment of metal within the dotted lines should be $\frac{1}{4}$ in. long. To compensate for removal of this segment, a brass liner is fastened on with screws having countersunk heads.

A form of snap-ring packing that will give reasonable promise of remaining permanently leakproof is shown in Fig. 7. It is made by mounting two packing rings, having lap joints, on a single spring or bull ring and distributing the joints equidistant around. A dowel screwed into a hole in the body of the piston and engaging the three rings will avoid any chance of the rings shifting so that the joints will become matched. This probably is the most dependable of all devices for preventing leakage through the joints of snap packing rings.

St. Louis, Mo. A. J. DIXON.

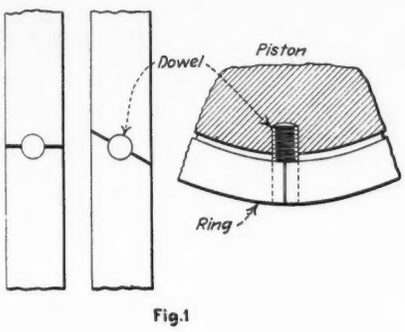


Fig.1

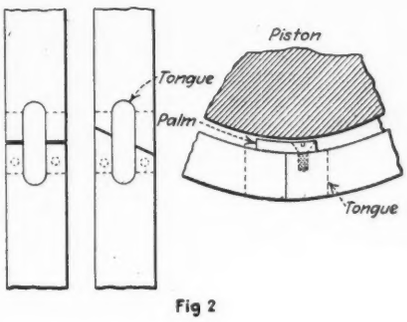


Fig 2

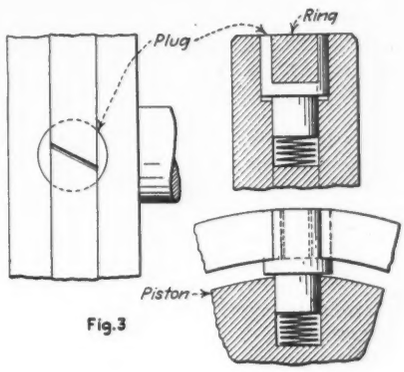


Fig.3

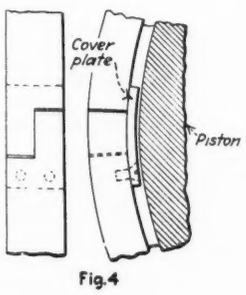


Fig.4

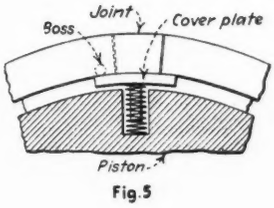


Fig.5

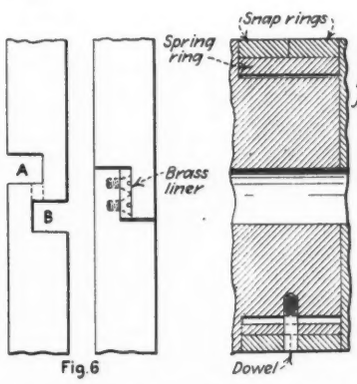


Fig.6

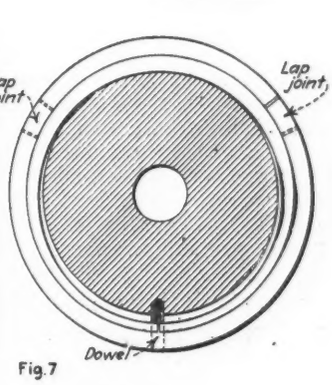


Fig.7

VARIOUS METHODS OF JOINING PISTON RINGS TO MINIMIZE STEAM LEAKAGE

Fig. 1—Simplest form of snap-ring joint. Fig. 2—Snap-ring joint closed with tongue and palm. Fig. 3—Plug-and-spring closing device. Fig. 4—Lap joint with coverplate. Fig. 5—Coverplate sprung against lap joint. Fig. 6—Lap joint with brass liner. Fig. 7—Packing rings mounted on spring ring.

From Among Readers' Problems

Conducted by
L. H. MORRISON

"OPEN" AND "CLOSED" SPRAY VALVES—*I notice from time to time reference to "open" and "closed" spray valves on oil engines. What is the difference?* J.K.

Taking up the air-injection diesel first, an "open" spray valve is one in which the oil is deposited in a receptacle open to the cylinder combustion space. The injection air is sealed off by a mechanically operated valve until the time for injection. On the other hand, in the "closed" spray valve the oil is deposited in a cavity in which the injection air is present, which cavity is sealed off from the engine cylinder by a mechanically operated valve.

Solid-injection diesels employ no air for injection, depending upon pump pressure. An "open" nozzle is one through which the oil can pass whenever the pump pressure exceeds the cylinder pressure; it has a check valve to prevent the cylinder gases from blowing back into the oil pipe line.

The closed nozzle has a spring-loaded valve, which lifts to admit oil into the engine cylinder only when the pump pressure goes above the spring loading. The oil pressure at the orifice is therefore constant during the entire spraying process.

—◆—

ADDING LOW PRESSURE TURBINE TO EXISTING PLANT—*We have three 7,500-sq.ft. boilers and three 1,000-kw. turbine-generators. Two boilers and two turbines are in operation, taking steam at 265 lb. The turbines exhaust against 8 lb. back pressure into dry kilns. We generate an average of 1,000,000 lb. of steam per 10-hr. day. About 600,000 lb. of steam passes through the turbines, and approximately one-half, or 300,000 lb., discharges through a back-pressure valve to the atmosphere. What horsepower would this waste steam develop with a low-pressure turbine? The installation of additional machinery is not necessary except from the point of steam economy. Would the savings justify the cost of installing the above-mentioned machine, if the power we generate costs 0.018c. per kilowatt-hour?* S.B.

S.B.

You should be able to purchase a low-pressure steam turbine with a steam rate of about 30 lb. per kilowatt-hour, when exhausting at 29-in. vacuum. As it is necessary to deliver around 300,000 lb. of 8-lb. steam to the driers in 10 hr., this steam will develop about 1,000 kw. per hour in one of the present back-pressure turbines. There is, then, 1,000 kw. to be generated by steam passing through the second back-pressure and the contemplated low-pressure turbines. The steam rate of the combination should not exceed 18 lb., so that 180,000 lb. of steam would be required, making the total 300,000 + 180,000 = 480,000 instead of the present 600,000 lb. per day.

The savings at a steam cost of 30c. per 1,000 lb. would be $36 a day, or about $7,200 a year of 200 days. The low-pressure turbine would be rated at about 500 kw., and, with the condenser, piping, etc., should not cost more than $25,000. This would give a return of almost 30 per cent on the investment.

—◆—

BRINE CORROSION RETARDER—*Will sodium chromate eliminate corrosion of pipe and ice cans placed in a brine tank?* C.B.R.

The influence of sodium chromate on the corrosion of iron and steel by calcium brine was investigated by the Corrosion Committee of the A.S.R.E. It was found that the addition of sodium dichromate to the brine gives an increased protection to iron and steel when the dichromate is neutralized, that is, converted to sodium chromate by the addition of caustic soda. In other words, sodium chromate is a more efficient retarder for iron and steel than the dichromate per unit of chromate in the brine. Because of its common use in the arts, however, the dichromate is cheaper and more readily available than the chromate. It is, therefore, advisable to purchase the dichromate and neutralize it in the brine tank.

If the 74 per cent commercial flake caustic soda is used for neutralization, 35 lb. should be added for each 100 lb. of dichromate. Slightly less than this amount of caustic is necessary if the brine is alkaline before treatment.

The most effective concentration of dichromate to use is 2 lb. per 1,000 cu.ft. of brine. It is not advisable to use this salt in open systems, however, because the workmen handling the brine are likely to be affected by "chrome itch."

Test on galvanized material, brass, bronze and admiralty metal showed that about 90 per cent protection to these metals can be obtained by the use of dichromate neutralized with caustic soda.

By using sodium phosphate in sodium brine the corrosion rate of galvanized metal is reduced over 95 per cent, the addition being 1 g. per liter of $Na_2HPO_4 \cdot 12H_2O$. Also, a 95 per cent protection of iron and steel is obtained by this addition of phosphate. Tests on brass, bronze and admiralty show that good protection of these metals is obtained by this retarder.

Although sodium silicate is an excellent corrosion preventive for iron and steel in fresh water, it has been found ineffective in brines. Tests, made both in the laboratory and in plants, using 40-deg. Be. silicate have demonstrated that there is little protection given either to galvanizing or to bare metal.

—◆—

CYLINDER LUBRICATION FOR STEAM ENGINE—*We are employing 250-lb. steam superheated 100 deg. in our horizontal steam engines, but have failed to find the proper lubricating oil. What should be used?* D.F.

Cylinder oils for saturated steam are compounded, that is, mixed with a fatty oil such as tallow or lard, to produce an emulsion with the condensation water in the cylinder. This insures that the oil will adhere to the walls. In case of superheated steam the fatty oil, if in too great a percentage, will be broken down by the high temperature. Consequently the amount of fatty oil should be low, say, 2 per cent.

The oil should have a viscosity of 180 to 195 sec. Saybolt at 210 deg. F. The slight compounding will cause emulsification as soon as the expansion of the steam throws down some moisture. It is best to apply the oil by a mechanical lubricator, with the lines to the valves and to at least one point along the cylinder barrel.

—◆—

HIGH TEMPERATURE REDUCES BEARING FRICTION—*A lecturer before an association stated that a cool bearing might actually develop more friction than a hot one. How can this be?* F.A.G.

The friction in a bearing is not due to metallic contact between the journal and the babbitt, but to the frictional resistance offered by one thickness of oil sliding on an adjacent thickness. This internal resistance is a measure of the oil's viscosity. As the viscosity, or resistance, decreases with an increase in temperature, there will be less friction at a high than at a low bearing temperature. However, as the heat is produced by friction, a high temperature is indicative of excessive bearing friction, which if not reduced may cause the bearing to melt.

It is of advantage to have an oil of the proper viscosity at low temperatures, which is why an oil suitable for a rapidly moving shaft, such as a spindle, is thinner, or has a lower viscosity, than an oil for a slow-moving lineshaft, which must endure high bearing pressures, and this calls for an oil of considerable body.

PREVIOUS QUESTIONS
DISCUSSED BY READERS

POWER in our plant is generated at 480 volts, 3 phases, 60 cycles and is supplied to the distribution centers by six 1,500,000-circ.mil single-conductor, cambric-insulated, lead-covered cables. These cables are 870 ft. long, are carried on a wooden structure and are supported in a vertical plane with the phases arranged A, B, C, A, B, C. With 480 volts at the power house and 600-amp. load on each set of feeders, the voltage at the distribution centers is 435. I should like to know how to reduce the voltage drop. E.B.T.

AN ANALYSIS of the problem quickly shows that the reactance of the line is causing the voltage drop. The inductance between two wires is a function of the distance between the conductor, so that the smaller the separation the less the inductance. If the cables of each set of feeders are arranged so that they form a triangle touching each other the reactance will be at a minimum.

Iron supports may be used without appreciably increasing the reactance of the feeders. Large masses of iron should be avoided, the iron should not extend for any length parallel to the feeders, and it should be grounded.

The voltage drop may be compensated for in two other ways, by a capacitor, an over-excited synchronous motor, a synchronous condenser, or a booster transformer. By adjusting the capacitance in the circuit (number of static condensers) or the excitation of the synchronous condenser, the voltage at the load may be adjusted to a suitable value. This equipment would be located at the load or distribution center. This would have the added advantage of increasing the available kilowatt capacity of the generators by reducing the wattless kilovolt-ampere load. The addition of a booster transformer to overcome the voltage drop will reduce the present power factor. The booster transformer would have to be of special design and therefore is not recommended.

P. CILLEY.
Salem, Mass.

—◆—

THERE ARE TWO FACTORS in the problem as submitted that are not given, which are necessary for an exact solution. These are the power factor of the load and the conductor spacing from center to center. However, figures for these will be assumed, and voltages calculated to show what can be accomplished by change in conductor arrangement and spacing.

Assume that the conductor spacing is 12-in. center vertical arrangement and the power factor of the load is 85 per cent lagging. With 600 amperes flowing, the calculated voltage at the load end, with 480 volts at the sending end, is 434 volts between conductors. If we now change the arrangement to a triangle, with 12-in. spacing, the load volts will rise to 437. By decreasing the triangle, we get, with an 8-in. triangle, load volts, 442; 6-in. triangle, 445; 3-in. triangle, 455. The latter almost amounts to cabling the conductors.

Iron brackets can be used for supports, provided that all conductors of a feeder lie wholly within any complete iron loop that may enter into the design of the bracket; but if there are no iron loops such brackets are entirely satisfactory. It should be remembered that there is a magnetic force between cables carrying large currents, which may reach large proportions in the event of short circuits.

This is a considerable amount of power to send for so long a distance using such a low voltage, and requires a heavy investment in copper. One wonders why the extra cost of lead sheaths for aerial service was incurred. Also, why the voltage was not stepped up for transmission, which would have required less copper, less costly supports and easier control of the voltage. As the matter now stands, rearranging the conductors as suggested, within practicable limits, is about the only remedy for the low voltage conditions.

Tacoma, Wash. R. E. TOWNE.
Consulting Engineer.

—◆—

IN THE PROBLEM BY E.B.T. sufficient data are not given to calculate the drop in the line. However, the high voltage drop is undoubtedly due to the reactance of the circuit. The drop caused by line resistance is about 7 volts when the load is 600 amp. The total drop is 480 — 435 = 45 volts, of which 45 — 7 = 38 volts must be the reactance. This can be accounted for in various ways. First, the conductors are too large for alternating-current service. A much better arrangement would have been to use 500,000-circ.mil conductors.

Satisfactory operation could have been obtained with four sets of 500,000-circ.mil conductors instead of two 1,500,000-circ.mil circuits. These, spaced on 3-in. centers in a vertical plane, would have caused a drop of about 28 volts when carrying a 300-amp. load. The four sets of conductors have only two-thirds the copper used in the present line, yet the volts drop is less than two-thirds. Because of the skin effect part of the copper in the present conductors is of little use.

The voltage drop is apparently unusually high in the present conductors. This is probably caused by an excessive distance between the conductors; the presence of iron supports or other parts that increase the inductance; the conductors not being transposed; a low power factor; and, as already mentioned, the skin effect of the large conductors.

Now that the line is installed, about the best that can be done is to group the conductors into a triangle and place them as closely together as possible. Iron supports may be used provided they surround the three conductors as a group. C. E. WILLIAMS.
Philadelphia, Pa.

▼

A Question for Our Readers

WHAT is the most direct way by which electricity can be obtained from the sun's radiant heat? What methods have been suggested but not carried out? P.M.

Suitable answers from readers will be paid for and published in the June 30 number

▼

WE ARE interested in learning the experiences of other industrial plants in burning high-grade, low-volatile coals compared with high-volatile slack in pulverized-fuel installations. We have been burning coals costing between $0.35 and $1.80 f.o.b. mines and seem to get the cheapest steam from 28 per cent volatile coals, costing $1.25 f.o.b. C.B.F.

HIGH-VOLATILE COALS have several advantages over low-volatile grades. One of the chief advantages is that the high-volatile usually indicates high heat content per unit of dry weight.

For a pulverized-fuel plant, my experience has covered coals varying from Welsh anthracite dust having a very low-volatile content and about 2½ per cent of ash, to coals with high volatile and high ash.

It seems that, for pulverized fuel, coals must contain enough volatile to promote flame propagation and to assist in maintaining a temperature in the furnace which eventually raises the carbon content to a temperature sufficiently high to allow oxygen to combine with it, thus completing combustion of the coal. With low-volatile coals, flame propagation is slow, uncertain and practically impossible in a water-wall furnace. With a brick furnace it would be possible to operate with lower-volatile coals fairly satisfactorily. Above an amount sufficient to maintain the flame, furnace volumes enter the picture. The higher the volatile the greater the furnace volume must be per unit of coal burned for efficient combustion.

J. C. HUTTON,
Price Bros. & Co., Ltd.
Quebec City, Que.

Refrigerating Engineers Meet at Kansas City

Discuss industrial applications of refrigeration, commercial-domestic machinery and new thermal problems at three-day convention

AT THE eighteenth western meeting of the American Society of Refrigerating Engineers, held at the Kansas City Athletic Club on May 6, 7 and 8, a variety of excellent papers, dealing principally with industrial applications of refrigeration, commercial-domestic machinery, and new thermal problems, was presented. Registration totalled 160. Entertainment was lavish. Eugene M. Dodds, chairman, and others of the local committee deserve much praise. Mornings were reserved for the technical sessions. Afternoons were devoted to automobile tours of the city, inspection trips to industrial plants, and golf. At a welcome luncheon on the first day unusual demonstrations with liquid air were made by Dr. Hamilton P. Cady. Other entertainment consisted of a stag party featured by a variety of athletic performances, and the formal banquet, with dancing and vaudeville turns.

Revised Constitution Adopted

Aside from the technical program, an action of note was the adoption of the revised constitution. A new handbook on refrigeration is to be prepared by the society. Announcement was made of the meeting in January at Cleveland to be held jointly with the American Society of Heating and Ventilating Engineers.

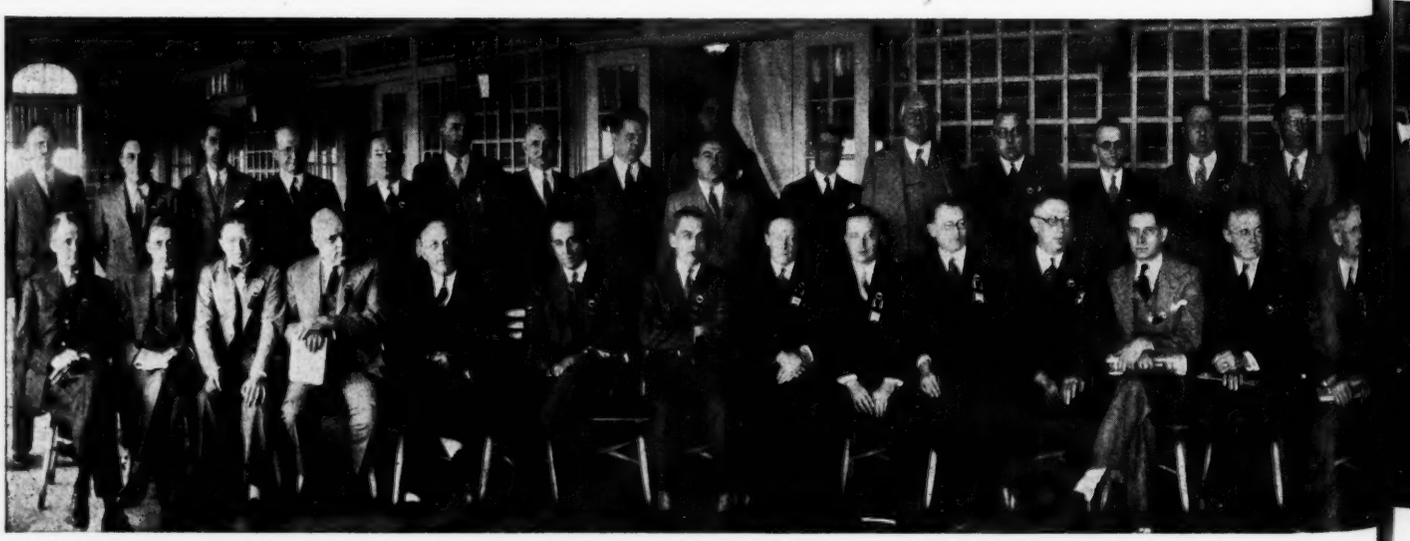
Of the fourteen papers offered, a number are of interest to the power field. Harris Pruitt pictured the refrigerating requirements for oil refining, particularly in the removal of wax from paraffin-base lubricating oils. The first dewaxing method used was "cold settling." Modern refineries dewax by the use of centrifuges or filter presses and obtain oils that have cold tests ranging from 25 to —15 deg. F. Of the various methods and equipment used for chilling the oil to be dewaxed, the author described one featured by a chilling surface costing about one-fifth that of the ordinary equipment. Naphtha is mixed with the lubricating stock to give the resultant solution a lower specific gravity than that of the waxes. The greater this differential the better, since the centrifuges depend on the difference in specific gravity to effect the separation of the waxes. The author considered the cost of chilling by far the highest expense in the manufacture of low cold-test oils. When this expense is reduced, he contended, more and more refrigeration will be used in the oil industry.

Human-Comfort Refrigeration

Discussing refrigeration in air conditioning for comfort, Maurice Olchoff summarized the results from recent studies regarding the heat losses from the human body and the effect of temperature, humidity and air motion on human comfort. Tabulated data were given to show the relations between the heat loss from the human body by evaporation, radiation and convection, and the dry bulb temperature; and the desirable indoor temperature corresponding to outside temperatures. Of the several air-conditioning systems that provide means for controlling both the temperature and moisture content of the air introduced, the author illustrated by diagram two methods of operation and worked out the refrigerating requirements. One system uses recirculated air for reheating, and the other uses steam to reheat the air to proper condition. Brief comment followed on the three principal refrigerants in air-conditioning work, ammonia, carbon dioxide and carrene, and on the requirements of the equipment used.

Discussion of the paper indicated that comfort cooling by ice in the home might readily compete with air conditioning, owing to the less expensive installation required.

R. H. Tait, consulting engineer, of St. Louis, mentioned a few of the considerations that render the well-planned drinking-water system more desirable than the iced water cooler. The essentials for individually operated mechanical units for small offices or shops were considered briefly, and a number of diagrams presented to show typical designs for systems in a variety of buildings served by a central plant, using open- or closed-type coolers, depending upon the head. Specific requirements for a definite plant were assumed and the details of the design, such as quantity



Members of the American Society of Refrigerating Engineers gathered in front of

of water, line friction, refrigerating effect and power for circulation, were worked out in the paper.

Discussion turned to the importance in small unit systems of precooling the incoming with the outgoing water, the ratio of water consumed to that wasted, in larger installations, and the necessity of adjusting feed valves in the risers to prevent short circuiting.

Management Control

Management control of a large group of ice properties was the topic of Arthur T. Mullergren, consulting engineer, of Kansas City, Mo., who discussed the essential features that should be considered in the formation of a consolidation. Its successful operation depends upon the properties and their locations, the proper financial structure and efficient management. Each of these items was considered.

Automatic Control for Unit Coolers

Use of unit coolers in lieu of pipe coils, wherever accurate maintenance of above-freezing cold-room temperatures is required, as in the storage of fruit and other products, has been advanced by the recent perfection of suitable automatic control equipment that will remove the frost on the heat-absorbing surfaces when it has accumulated to a predetermined thickness. A number of these controls that may be adapted to any conventional design of unit cooler were described in a paper by Thomas W. Carraway. The units may be of the direct-expansion type or may use brine. In either case the control is reported to be positive and efficient. With forced circulation the air does not stratify, so that uniform temperatures in the room are maintained. By means of a thermostat and defrosting switch the refrigerant is shut off when the frost has accumulated to a predetermined thickness. When the frost has melted, the automatic equipment again turns on the refrigerant. The heat of fusion absorbed in changing the solid frost to water prevents temperature rise in the room during the period of defrosting.

With a view to stimulating thought on new uses for refrigeration, Hugh J. Krampe, of the Armstrong Cork & Insulation Company, presented a symposium on test rooms. Suggestions for the building of these test rooms were as follows:

Build the room big enough and with plenty of height, initially.

Use as insulation at least 8 in. of good corkboard erected according to a specification which will not permit of air infiltration. The inside finish should be a proved asphalt emulsion.

Inside framing for carrying coils and pan and ceiling preferably should be of steel and must be completely within the room. No members should penetrate the insulation, which must be continuous over the ceiling deck. The ceiling deck should be of metal or well seasoned painted D. & M., $1\frac{3}{8}$-in. lumber.

The door must be big enough to permit of bringing in the maximum size of equipment for test. Provide thermocouple and pipe and electrical outlets. Place electric bulbs in vapor-proof receptacles. Thoroughly seal the wire if in conduits.

Provide observation windows with thoroughly sealed glass, with four air spaces. Provide adequate safety measures for operators. Have an ante-room if possible.

Raw-Water Treatment

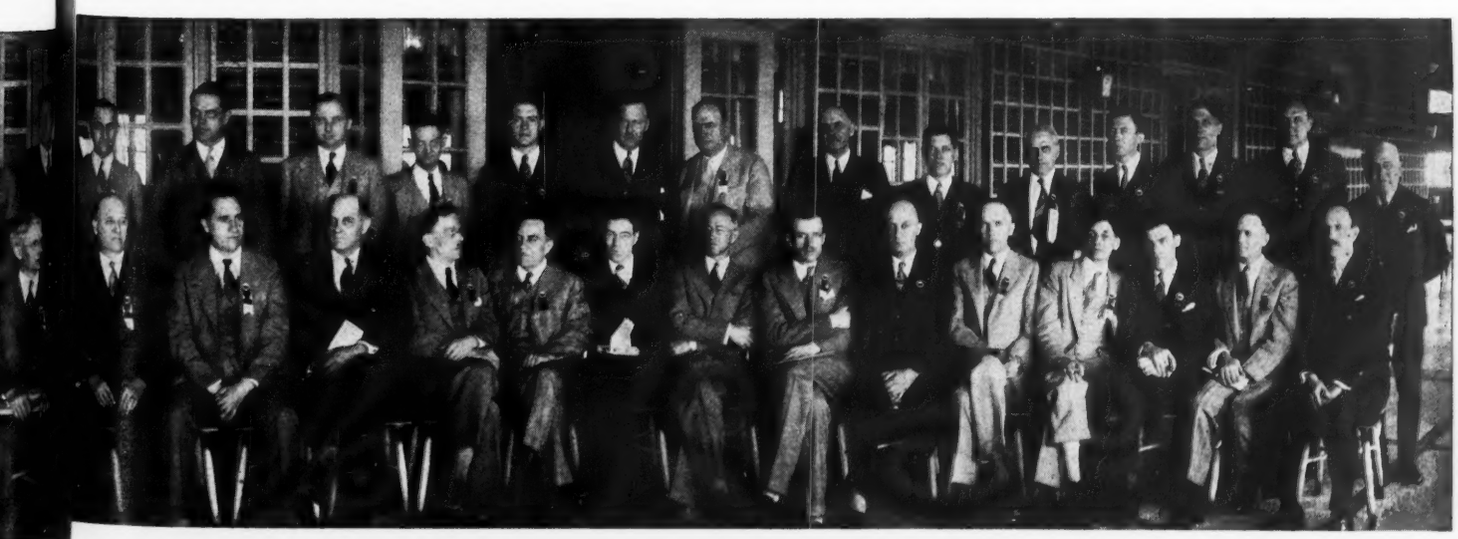
In a paper entitled "The Chemistry of Water Treatment," Dana Burks, Jr., of the University of Illinois, showed how chemical treatment of water will produce solutions possessing the qualities most desirable in raw-water ice manufacture. To obtain the most effective operation of the chemical processes involved, strict attention to efficient control is essential. When efficient water treatment is combined with effective air agitation, it was the author's prediction that any water considered fit for industrial supply may be used in the production of marketable ice in electrified raw-water plants. Subjects touched upon were air agitation, the desirability of low concentration of salts, use of coagulating agents, neutralization of solutions resulting from lime treatment, and the new magnesium-zeolite method developed at the University of Illinois to reduce the salt concentration of solutions containing a predominating concentration of sodium bicarbonate.

Factors Affecting Melting

Another paper dealing with ice, but this time with the factors affecting melting rates, was given in abstract by Paul W. Scates, of the University of Tennessee. Ice manufacturers in certain sections of the country have discovered that ice shipped into some areas melts at a different rate than in other areas of corresponding temperature and wind velocity. Evidently a third factor, humidity, had a decided influence on the ice melting, so a series of tests were run at the university to determine the variation of melting rates with humidities at different air velocities when 80-deg. air is permitted to pass over a block of ice at 30 deg. It was found that humidity played an important part in the melting rate of ice. It was shown that from $17\frac{1}{2}$ per cent humidity up, the melting rate increases rapidly with increase of humidity; also the melting rate at 75 to 100 per cent relative humidity is much faster than at 25 to 50 per cent, this variation being dependent upon the "wetted surface." Melting rates were much faster for high air velocities than for low velocities. The complete data were presented in curves, and the author outlined, as well, the complete test set-up and procedure.

Fuel Costs Per Ton of Ice

D. W. McKay of the Cooper-Bessemer Corporation read excerpts from a paper comparing the electric motor and internal-combustion engine using gas and oil as a drive for ammonia compressors. Direct-connected and belt-driven units of 50, 100 and 250 hp. capacity were considered. Figures for the 100-hp. units covering current and fuel cost per ton of ice were 48.61c. for the motor, 9.31c. for the gas engine and 6.81c. for the diesel engine.



convention headquarters, the Kansas City Athletic Club, where they met May 6, 7 and 8

Diving Bell Protects Submerged Motor of Deepwell Pump

In the February 21 number of the "V. D. I. Zeitschrift" Dr. W. Benedict described a new German development in deepwell pumps. The motor, attached directly to and submerged with the pump, is cooled by surrounding water yet protected from all contact with water by the use of a "diving bell" and other protective devices. The accompanying article is a digest of that appearing in the "Zeitschrift."

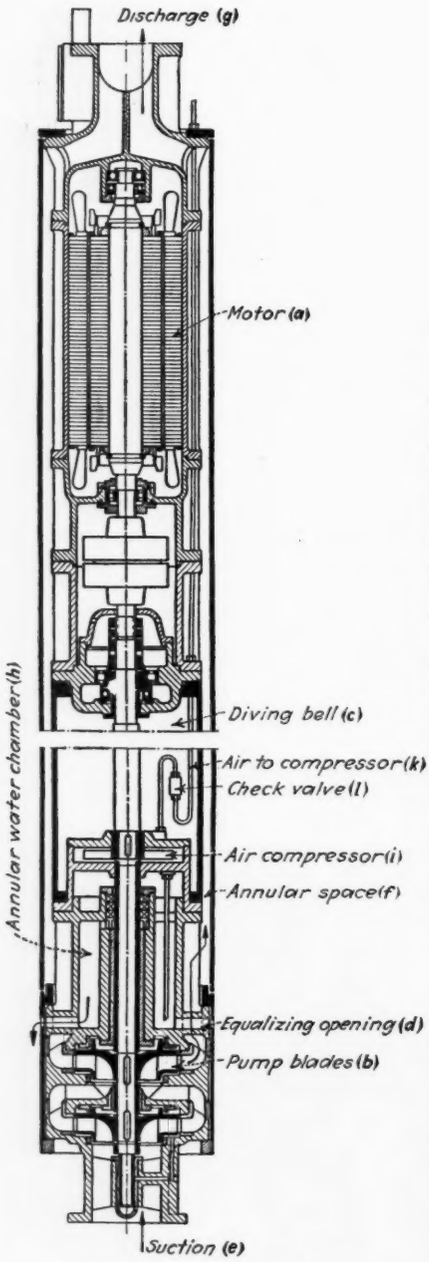


Fig. 1—Cross-section of the Wernert submerged pump, showing motor in the pump casing

THE Wernert submerged pump shown in the accompanying illustration is intended primarily for deepwell operation. The motor, with accessories, is submerged with the pump below water level. There is no stuffing box between motor and pump chambers, yet the pump is guarded from all contact with water by the use of a "diving bell" arrangement and other protective devices. High efficiency is obtained by the use of a standard motor and centrifugal pump blades of improved type.

The customary forms of deepwell pump with the drive at the well surface require either a long rotating shaft or a long plunger pump rod. Both give trouble with continued use. In plunger pumps difficulties are encountered with stuffing boxes and rod packing, because of leaks, sand clogging and corrosion of the pump element. It has also proved difficult to solve the problem by submerging the motor, because of the difficulties of protecting the sensitive electrical equipment by stuffing boxes and rod packing.

Referring to Fig. 1, it will be noticed that the motor is placed within the body of the casing of the pump, thus avoiding a long shaft. Penetration of fluids into the motor is prevented by the intervening air chamber, resembling a diving bell, located at the lower, or driving, end of the motor. This chamber is in direct communication with the surrounding water in the borehole through equalizer holes below. Through these the air in chamber is compressed until its pressure equals that of the surrounding water in the borehole.

As this surrounding pressure changes, due to changes of outside water level, the water within the diving bell assumes a position determined by the pressure and by the mass of air present. The motor, always surrounded by air, is thereby protected from water.

If the outside water level falls below the equalizer holes, the remaining water in the bell is released and the motor functions under atmospheric pressure.

Operation of the pump is as follows: The centrifugal blades *b* draw the water through the suction pipe at *e*, forcing it into the annular space *f* surrounding the motor and diving bell. From this space it is discharged through opening *g* above.

Air cannot escape from the bell or motor. Even in case of a leak in the casing of the diving bell, water will not reach the motor. Incidentally, the motor is constantly kept cool.

Should the water within the annular casing flow into the diving bell, the level therein will not rise, since equilibrium is established through the opening *d*. Neither can the air within the diving bell become absorbed, in case of a leak in the pump, for the water within the annular space *h* would then be discharged into the bell via a waste chamber through a drainage orifice.

Should air escape unforeseen, the air

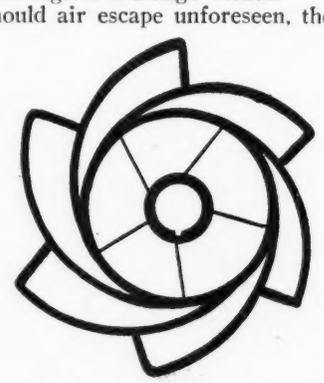


Fig. 2—End view of type of impeller shown in cross-section in Fig. 3

compressor *i* would force the water from the diving bell into the well through the orifice *d*. During operation the compressor draws in air through the feed pipe *k*.

When the water is forced below the lower opening of the suction pipe the compressor ceases to function until the fluid again reaches the level of the compressor. Check valve *l* prevents the escape of air from the diving bell.

The motor uses a short-circuit, double squirrel-cage rotor without sealing rings. It is fed at a voltage of 220, 380 or 500.

Construction and Efficiency

The pump shaft with pump rotor is coupled flexibly to the motor. Under the most favorable working conditions the spiral blade design shown in Fig. 2 makes it possible to keep the outside pump diameter only slightly larger than the outer diameter of the impeller. In this way rotation is converted into pressure without changing the direction of the water current, so that eddy currents are reduced to a minimum. Applied to

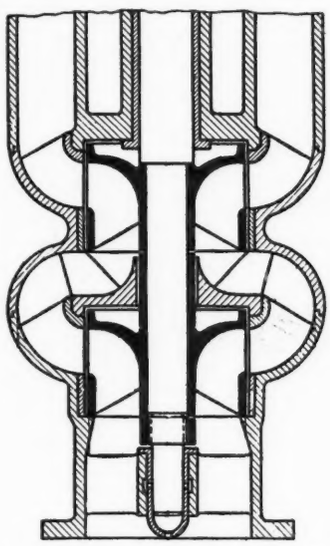


Fig. 3—Sectional Elevation of the Blades for a Pump of Small Diameter

a double-impeller pump, this blade design is serviceable for hydraulic heads exceeding 300 feet.

Fig. 3 shows a modified construction of the blades shown in Fig. 1 for smaller pumps, for lower hydraulic heads and larger volumes of discharge. The supply pipe is about the same diameter as the impeller.

The efficiency of this blade construction varies from 75 per cent to over 80 per cent. Since the efficiencies remain high during load fluctuations, overloading of the motor is avoided.

After the design of the Wernert submerged pump had been perfected, a water supply plant of ten pumps, of a capacity of 630,000 to 760,000 gal. per day per pump, was built. These pumps are used to deliver water from deepwells to the main water-works pump. They have been in continuous 24-hr.-a-day operation since May, 1930, with satisfactory results. This type of pump is not satisfactory, however, with dirty or salty water.

Municipal Waste as Fuel For Power Generation*

By E. E. BUTTERFIELD

ACCORDING to prevailing American practice, mixed refuse consists of garbage and rubbish in the proportion in which they are collected. Garbage as the refuse from food materials consists of fat, carbohydrates, water and ash.

The water content of garbage as received varies from 55 to 81 per cent, with an annual average of about 75 per cent. The lower heating value of 8,800 B.t.u. per pound of average garbage, dry basis, becomes 1,528 B.t.u. per pound for the same material as received containing 72.13 per cent water and 6.7 per cent of hydrogen in the dry substance.

Rubbish consists of combustible and incombustible material in proportions which vary from 45 to 78 per cent of the former to 55 to 22 per cent of the latter. The incombustible materials are of only passing interest, in that they depreciate the fuel value of the rubbish, and are best removed from it before used as fuel. The lower heating value of the ash- and moisture-free combustible in rubbish is 8,321 B.t.u. per pound, practically identical with that of the dry oak wood substance. Attributing to the ash- and moisture-free combustible and rubbish the same hydrogen content as that of dry oak wood, 6.02 per cent, the net lower heating value of rubbish combustible material, as received, becomes 6,673 B.t.u. per pound. Mixed refuse consists of garbage and rubbish in proportions varying from 86:14 to 60:40. The properties of the mixture are the additive properties of its constituents. It will contain, on an average, about 50 per cent moisture, and the net lower heating value of a 2 to 1 mixture of average material is only 2,408 B.t.u. per pound. Pre-drying the garbage and removal of gross incombustibles from the rubbish will raise the lower heating value of the mixture to 2,907 B.t.u. per pound of original material or to 7,377 B.t.u. per pound of the dry mixture.

Steam generation from mixed refuse, as received, with the high water content and low net heating value, is decidedly at a disadvantage. The dry fuels have heating values equivalent to the best wood fuels. Trying to burn garbage as received throws an unnecessary load on the combustion process by the interference of the water molecules with the normal combustion of hydrogen, carbon and carbon monoxide as they are liberated from the garbage at the temperature of the combustion.

Refuse incinerators in Miami, Fla., and Atlanta, Ga., are now producing steam from refuse, as received, in quantities equivalent to 1.14 and 1.29 lb. of steam, from and at 212 deg. F. per pound of fuel, respectively. Predried garbage mixed with rubbish in the original proportions yields about twice as much steam per pound of original material. With pre-dried garbage derived from 1,000,000 population contributing 2 lb. of 86 to 14 mixture per person per day, an annual net power output of 58,000,000 kw.-hr. should be obtained from a steam electric generating set, the turbine operating at 350 lb. abs. pressure and 200 deg. superheat, and bleeding 48,450 lb. of steam per hour at 90 lb. abs. pressure per hour for drying garbage.

*From paper presented at the 36th convention of the American Society of Municipal Engineers.

Advantages of Pre-Drying

Burning wet garbage and rubbish at the time of its collection and generating steam, it has been difficult to find a suitable use for the steam at the time of its production. Pre-drying the garbage permits of storage, and the steam or power can be generated as needed, within the limits of its production from such fuel. For such definitely limited production of power, another municipal activity, sewage disposal, seems to provide a suitable outlet. For methods of sewage disposal other than the activated sludge process power requirements are small and can probably be met by burning wet garbage and rubbish as fuel, provided the fuel supply can be adjusted for continuous operation.

The activated sludge process requires considerably more power for forcing compressed air through the sewage. In a city of about 1,000,000 population it will be found that 19,600 kw.-hr. per year are required for sewage disposal by the activated sludge process as against the 58,000,000 kw.-hr. per year available from burning pre-dried garbage and rubbish.

▼

Plan to Develop Power Resources in Finland

A proposal has just been submitted to the Finnish Government to develop on a large scale various hydro-electric and industrial plants in Finland. The scheme would be financed by an international combine in Belgium, the Société Financiére de Transport et d'Enterprises Industrielles.

Plans for the initial stage of the development provide for the extension of the Imatra hydro-electric plant to double its present capacity and the erection of several industrial plants to utilize the energy thus produced. In the entire project it is proposed to invest a capital of $30,000,000. The total power developed will be about 100,000 kilowatts.

WHAT'S NEW IN PLANT EQUIPMENT

Oil-Circulating Shaft Bearing

AUTOMATIC circulation of oil from a well in the base of the bearing around the shaft and back to the well again is an important feature of the Robins-Jones bearing now being put out by the Robins Conveying Belt Company, 15 Park Row, New York, N. Y. Referring to the sectional view, oil is drawn up from the well in the base through a series of

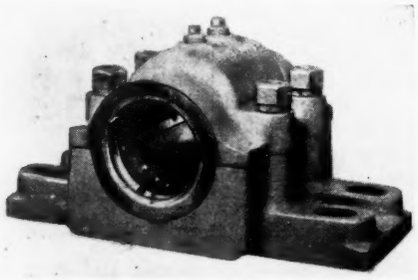


Fig. 1—Robins-Jones pillow block bearing

parallel holes or ducts in the bearing surface by the rotation of the shaft and distributed over the bearing surface. At the center, or parting of the base and cap, there are recesses from which scavenger holes return excess oil to the well.

Automatic lubrication of the bearing is not affected by the direction of rotation of the shaft, and the range of speed to which the bearing is adaptable is from 1 to 5,000 r.p.m. The load or pressure may be applied to either halves of the bearing, as an oil well and oil passage similar to those in the base are provided in the bearing cap. It may also be applied to vertical as well as horizontal shafts by proper arrangement of the oil well and oil ducts to the bearing surface. With the cap removed the lower liner can be removed by rotating it around the shaft, thus obviating the necessity of lifting the shaft out of the bearing.

The bearings are available as separate pillow blocks, or they may be obtained specially designed as a built-in unit of the machine.

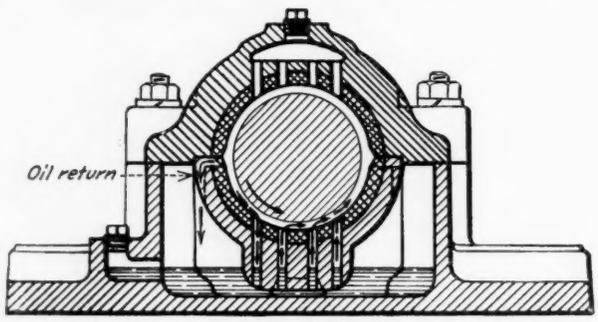


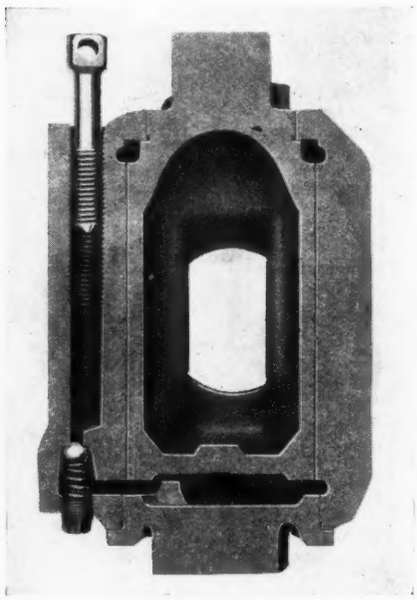
Fig. 2—Cross-section of bearing, showing oil ducts from reservoir. Shaft clearance is exaggerated for clearness

Lubricated Plug Valve

USE OF A STRAIGHT cylindrical plug instead of a tapered plug, elimination of packing and gaskets and provision for lubricating the entire plug are some of the important features of the new line of "ACF" Milliken valves recently brought out by the American Car & Foundry Company, Valve Division, 30 Church St., New York, N. Y.

The valve is offered for use on water, steam, boiler blowoff, oil, gasoline and chemical lines and can be furnished in sizes from 1 to 8 in. and for pressures of 125, 175 and 250 lb., also in the Venturi type for 500 lb., both in screwed and flanged models. It has the same face-to-face dimension as standard flanged gate valves and opens and closes with a quarter turn, having a positive stop. It is also available in aluminum and acid-resisting bronze in sizes up to 3 in., as well as in other metals to suit various purposes.

As previously mentioned, provision is made for lubricating the entire plug. The construction is based on the principle of protecting all points where leaks might occur with a viscuous lubricant under a pressure equal to or greater than the pressure of the liquid or gas handled. A lubricant chamber is provided on the side of the valve and pressure is applied by means of a screw, as shown. The lubricant is forced into a chamber below the plug, from which it raises through four vertical ducts, where it seals the top of the plug against leakage. It is pointed out by the manufacturer that by using a straight plug the plugs are interchangeable and no grinding is necessary to make the valve tight.



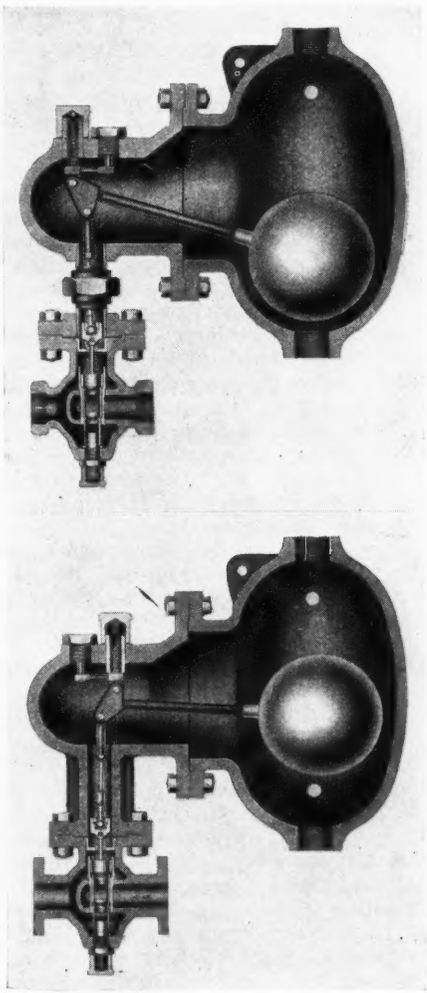
Sectional view of "ACF" Milliken valve

Liquid-Level Controller

IN THE ACCOMPANYING illustrations is shown a new type of controller, interchangeable for draining or filling service, that has been developed recently by the Mercon Regulator Company, 1 La Salle St., Chicago, Ill. The design of this float-operated, balanced-piston valve embodies a number of features new to this class of equipment, such as adjustable capacity, graduated valve travel, variable mechanical advantage for the float, adjustable liquid level, adjustable connection between float and valve bodies and interchangeability of service.

To give the equivalent of a smaller

valve for light loads with its more accurate regulation, the Mercon valve is equipped with adjustable ports. The stationary valve cage has two opposing ports, each uniformly 90 deg. wide, and the valve piston is similar in construction. For maximum capacity the ports of one register exactly with the ports of the other. If the pressure differential across the valve should be greater than anticipated, or the required flow less, the piston can be rotated from the outside while the controller is in service. This is accomplished by removing the cap at the bottom of the valve and turning a jacking screw to vary the port width from maximum to zero. As the valve is assembled so that the ports in the cage are across the axis of the pipe, a line at the lower end of the jacking screw indicates the port opening. If desired, a continued turning of the screw in an upward direction will jack the valve wide open.



Views of filling and drainage controller

The float is attached rigidly to a triangular link which carries the fulcrum and also the point of attachment for the valve stem. Contrary to the usual arrangement, the latter is below the line of centers of the fulcrum and float. As the float lifts the valve from the closed position, the ratio of valve travel to float movement is small, but increases rapidly as the valve opens farther. At low rates of flow this relatively slow movement of the valve permits accurate control.

To vary the liquid level while the controller is in service, the fulcrum may be raised or lowered by the screw-adjusting device shown.

Changing the controller from drainage to filling is accomplished by interchanging the fulcrum-adjusting screw and the guide-pin plug. Both are symmetrically placed with reference to the vertical centerline of the valve body and are threaded alike. Also, the triangular link must be reversed so that an upward movement of the float closes the valve.

Valve and float bodies are of cast iron for pressures up to 250 lb., and of cast steel for higher pressures and temperatures. Working parts of stainless steel are adapted to any water service, hot or cold, oil, and various chemicals. The float is heavy-gage stainless steel or copper, according to the pressure or nature of the liquid handled. The float chamber is tapped for standard gage-glass fittings. At present the controller is built with screwed or flanged ends for pipe sizes ranging from $\frac{3}{4}$ to 3 inches.

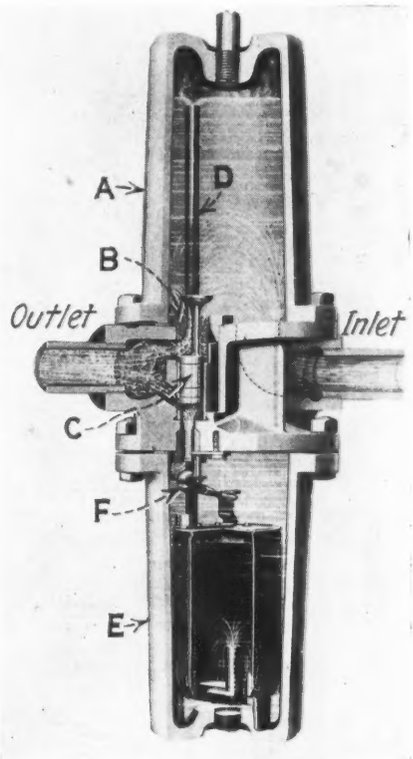
Compound Steam Trap

DEVELOPED primarily to overcome the troubles experienced with certain types of piston-operated traps, the new Armstrong compound trap illustrated is simple in design, has few moving parts and has a high capacity for a given diameter of discharge orifice.

The body of the new trap consists of two standard Armstrong trap bodies bolted to a piston housing. With this construction the entire trap mechanism is readily accessible. After removing the receiving chamber body *A* the piston valve seat *B* can be unscrewed and the main valve and piston *C*, as well as the piston liner, pulled out.

In the No. 230 series, for pressures up to 250 lb., the piston housing and bodies are made of semi-steel containing nickel and chromium. For high pressure and temperature service the bodies are one-piece forgings and the piston housing is machined from a solid steel billet. The valves are of a special alloy steel.

Briefly, the principle of operation of the trap is as follows: Assume that water comes to the trap as shown in the illustration and that the discharge valve is closed. The receiving chamber *A* fills until the water level rises above the top of the pilot tube *D*. When this occurs no more steam can enter the inverted bucket, and water instead of steam passes down the pilot tube into the pilot trap. The water level in the bucket rises, and the bucket loses its buoyancy and sinks, pulling the pilot valve *F* open. The pilot trap then discharges against the piston and opens the main valve.



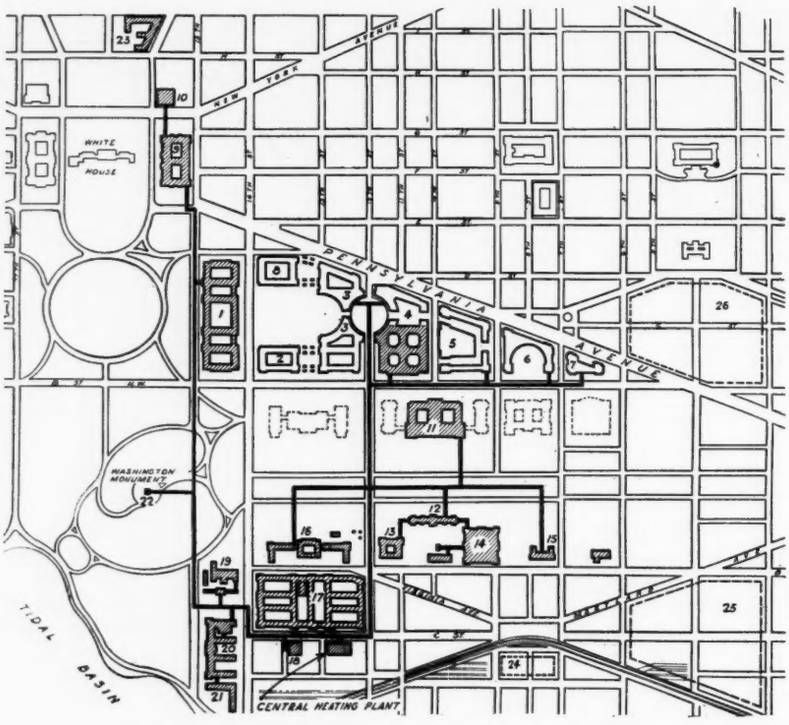
Cutaway view of Armstrong compound trap

When steam enters the trap, and the water level in the receiving chamber falls below the top of the pilot tube *D*, no more water can enter the pilot tube. Steam therefore enters the inverted bucket as soon as the water in the bucket and tube has been discharged. The incoming steam restores the buoyancy of the bucket, and the bucket rises and closes the pilot valve *F* before all the water leaves the upper chamber. With the pilot valve closed there is no longer pressure under the piston and it drops, closing the main valve.

The new trap is made in standard pipe line sizes from 1 to 3 in., by the Armstrong Machine Works, 812 Maple Street, Three Rivers, Mich.

NEWS of the FIELD

Contract Let for Design of Steam Plant To Heat 26 Washington Public Buildings



'Location of new heating plant and buildings it will serve

CONTRACT was signed last week by the United States Treasury Department with United Engineers & Constructors, Inc., of Philadelphia, for the preparation of plans for the new central heating plant and electrical distribution system to be built in Washington, D. C., at a cost of $5,749,000.

This new heating plant, which will be one of the largest in the country, will serve 26 government buildings, which, as shown on the map, are: (1) Department of Commerce, (2) Labor Department and Interestate Commerce Commission, with future connecting buildings; (3) Post Office Department, future; (4) Internal Revenue, (5) Department of Justice, future; (6) Archives future; (7) Coast Guard and independent establishments, future; (8) buildings to replace present municipal buildings, future; (9) Treasury Department, (10) Treasury Annex, No. 1; (11) New National Museum; (12) Smithsonian Institution and miscellaneous small buildings; (13) Freer Art Museum, (14) Old National Museum, (15) Army Medical Museum, (16) Department of Argiculture, (17) Argicultural Extensible Building, (18) Argicultural Economics Building, (19) Auditors, (20) Bureau of Engraving and Printing, (21) Liberty Loan, (22) Washington Monument, (23) Veterans' Bureau, (24) Federal Warehouse, future; (25) Army and Navy, proposed location, future; (26) municipal center, future.

In an average year these buildings, including those planned for the future, will consume 1,500,000,000 lb. of steam. The new heating plant will provide for 75 per cent of that capacity and will be designed to permit of future extensions. Steam will be distributed to the buildings through an underground system of pipes varying in diameter from 3 to 18 in., with an aggregate length of approximately 5 miles.

In connection with the heating plant, a substation will be built to distribute electric power, all of which is to be purchased from the Potomac Edison Company. The public buildings which will be supplied with steam and electric light and power in the initial installation will consume approximately 34,000,000 kw.-hr. in an average year with a maximum demand of approximately 18,000 kw. The future extensions will increase these demands by about 35 per cent.

The design of the plant will embody the most modern features in the combustion of fuels and production of steam, together with electrical design to provide service of maximum reliability at minmum investment cost. Special attention will be given to the architectural features of the plant which will be approved by the Fine Arts Commission of Washington.

Program for N.D.H.A. Meeting in Boston, June 2-5

PROGRAM has just been announced for the 22nd annual convention of the National District Heating Association, to be held in Boston, Mass., on June 2 to 5 with headquarters at the Hotel Statler. Six business and technical sessions are scheduled for the meeting, which will cover many phases of central heating systems. Entertainment features include inspection trips to points of engineering and historical interest in and around the city, a golf tournament and the annual banquet, with a special program for the women.

Committee reports to be presented at the technical sessions include: Report of the Research Committee on "Serving Industrial Requirements With Combination Power and Heating Plants," E. E. Dubry; Report of the Station Operating Committee covering "New Stations and Additions, Ideal Equipment for Operating on a Predetermined Load Factor, Cinder Abatement, Steps Necessary for Improving Operating Personnel, Availability Factors and Outages," H. J. Bauer; Report of Meters and Accessories Committee covering "Use of Stainless Steel Drums, Tests on Condensation Meters and Shunt Meters," J. J. Schenk; Report of Hot Water Committee, S. F. Delany; Report of Distribution Committee, Edward Lenz; and Report of Committee on Corrosion, J. H. Walker.

Papers to be given at the meeting are: "Condensation Meters: Their History, Development and Performance," B. M. Conaty; "Steam Flow Meters," H. M. Hammond; "An outline of Refrigerants and Refrigeration Systems Used in Air Conditioning," R. W. Waterfill; "Steam as an Activating Agent for Silica-Gel Air Conditioning," H. R. Warfield,

Jr.; "Research Developments in Corrosion," James Ashton; "Methods of Welding Pipe," E. R. Benedict; and "Development of a New Form of Underground Steam Main," G. Gottwald.

Midwest Coal Conference At Urbana, Ill., This Week

OVER 500 INDIVIDUALS, representing all phases of coal production, distribution and utilization are expected at the Second Midwest Bituminous Coal Conference, to be held at the University of Illinois, Urbana, May 21 and 22. This annual conclave, a development from the Indiana Fuel Conferences of some years' standing, originated at Purdue University, has come to be regarded as one of the outstanding symposiums on modern equipment and practical experimentation in the coal industry.

Sponsors of the 1931 Conference have keynoted the program as an unusual offering of practical results, covering prominent facts of fuel utilization as found in the laboratory and in the field during the past year. Sessions on "The Value of Midwest Coal," "Experimentation and Research," and "Industrial Utilization," offer discussion on such vital topics as modern coal preparation, natural gas competition, reconditioning of power plants, centrally prepared pulverized coal and the training of plant operators. The coal research program of the Illinois State Geological Survey is to be discussed. Other details of the program were given in the April 14 number.

Evidence of the scope of the interest in this Conference is apparent in the list of official cooperating sponsors, which includes the Coal Trade Association of Indiana, Fuels Division of American Society of Mechanical Engineers, Illinois Coal Bureau, Illinois State Geological Survey, Midwest Stoker Association, National Association of Power Engineers, and National Association of Purchasing Agents.

Second 80,000-Kw. Unit Ready at Huntley Station

THE SECOND 80,000-kw. turbine-generator in the 60-cycle section of the Charles R. Huntley station of the Buffalo General Electric Company is nearly ready to go on the line. The new unit, similar in every respect to generator No. 1 placed in service last December, operates at 1,800 r.p.m. on steam of 435 lb. pressure and 750 deg. F. temperature. Incorporated in these machines are two of the largest single-cylinder steam turbines ever built.

Assembly of generator No. 2 was completed about the middle of last month, and since that time the unit has been operated at half speed for testing purposes. Full capacity of the two generators will probably be used in July, when run-off diminishes at the hydro stations of the Niagara Hudson System.

NEW YORK POWER BOARD SWORN IN

Governor Roosevelt's appointees to the New York State Power Authority met for the first time in Albany on May 12 and were sworn in by Grace A. Reary in the presence of Lieutenant-Governor Lehman (seated). They are, left to right: Prof. James C. Bonbright; Delos Cosgrove; Frank P. Walsh, who was elected chairman; and Fred Freestone. Morris L. Cooke, fifth member of the Authority, did not attend the meeting

▼ ▼ ▼

Ask Permits of New Oregon Body for Big Hydro Projects

SEVERAL APPLICANTS for permits and licenses involving large developments have filed requests with the State Engineer of Oregon for authority to transfer their applications from the office of the Reclamation Commission to the new Hydro-Electric Commission.

The Columbia River Power Company, of Seattle, Wash., has asked for the transfer of its water-power petitions to the commission. This applicant is asking for authority to appropriate 90,000 sec.-ft. of water from the Columbia River, at Stevenson, Wash., for the development of 235,000 hp.; estimated cost, $15,000,000. Charles H. Lee, and R. W. Myers, of Oakland, Calif., have petitioned the commission to assume charge of applications filed by them on the Illinois and Rogue Rivers. The applications affect the following proposed developments: construction of a reservoir at Kerby, Josephine County, for the storage of 430,000 acre-ft. of water from the Illinois River, and the appropriation of 1,500-sec.ft. of such stored water for the development of 113,600 hp.; appropriation of 18,250 sec.-ft. of water from the Rogue River and a permit to store 80,000 acre-ft. from the same stream for the development of 290,000 hp. Another transfer of applications to the commission involves the J. G. Kelly holdings on the North Santiam River and at Marion Lake. This applicant asks permission to withdraw from river and lake 760 sec.-ft. of water for the development of approximately 69,590 horsepower.

At the same time application has been filed by the California Oregon Power Company with the California Division of Water Resources for permission to divert 3,000 sec.-ft. of water from the Klamath River for the purpose of developing power amounting to 54,545 hp. at an estimated cost of $4,500,000. This project was originally planned for construction in Oregon, but due to changes in the state laws affecting hydro-electric developments, the company decided to build it in California. The company announces, however, that plans are being made for the completion of its Prospect development on the Rogue River.

Contract Let for Final Stage of Oak Grove Project

COMPLETE DEVELOPMENT of the Oak Grove project as originally planned took another step forward last week, when the Pacific Northwest Public Service Company, Portland, Ore., let a contract to Sullivan & Doyle, Portland contractors, for 3,500 ft. of tunnel between the main fork of the Clackamas River and the Oak Grove Creek. The tunnel, which is to be 10 ft. in diameter, will ultimately be 3.7 miles long, and will deliver water from the main fork of the river to the present intake of the Oak Grove plant. The present contract will complete all the work to be done on the project this year. It is planned to take three years to complete the tunnel.

When first placed in service, the tunnel will be used as an open, unlined conduit, capable of carrying about 400 sec.-ft. of water. Later when the main fork of the Clackamas River is dammed to supply storage, the tunnel will be lined and operate as a pressure conduit.

Charles Day, Chairman of Day & Zimmermann, Dies

CHARLES DAY, chairman of the board of Day & Zimmermann, Inc., engineers of Philadelphia, Pa., and a director in many corporations, died on May 10 at the University Hospital in that city after an illness of ten days. He had recently returned from a trip to north Africa, and his illness was attributed to the effects of the tropical sun.

Born in Philadelphia on May 15, 1879, Mr. Day graduated from the University of Pennsylvania with an engineering degree in 1899. Three years later he established the engineering firm of Dodge & Day, specializing in management and construction work. In 1911 the company became Day & Zimmermann, and Mr. Day was its president until 1926, when he became chairman of the board.

As an authority on the efficient equipment of industrial plants and the management of public service corporations, he had lectured at the business schools of Harvard and Columbia. During the World War he was made a trustee of the Emergency Fleet Corporation and served on many government committees.

Mr. Day was a member of the board of managers of the Franklin Institute, a trustee of the University of Pennsylvania, a member of the American Society of Mechanical Engineers, American Institute of Electrical Engineers, Engineers' Club of New York and Engineers' Club of Philadelphia. He was the author of many articles on industrial management and in 1911 published a book on "Industrial Plants."

N. B. Ambler, Superintendent Of Muscle Shoals Plant, Dies

NATHAN B. AMBLER, hydro-electric engineer and superintendent of the Wilson Dam hydro-electric plant at Muscle Shoals, died suddenly at Florence, Ala., April 11, in his fifty-fifth year.

A native of Chatham, N. Y., Mr. Ambler received his degree in electrical engineering at Columbia University in 1900. After several positions in the electric railway field, he joined the Toronto Power Company in 1911 as superintendent of its Niagara Falls plant. Ten years later, when this company sold out to the Ontario Hydro-Electric Power Commission, Mr. Ambler went to New York with the firm of McClellan and Junkersfeld. In 1924 he joined Hugh L. Cooper & Company's organization as chief electrical inspector on the government's hydro-electric plant at Muscle Shoals. In the early part of 1926, when this plant was completed and turned over for operation, he became plant superintendent by special appointment of the Secretary of War, which place he held at the time of his death.

Mr. Ambler was a member of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

COMING CONVENTIONS

American Society of Mechanical Engineers. Lubrication meeting at Pennsylvania State College, May 22. Meeting at Hartford, Conn., June 1-3. National Oil and Gas Power Meeting at the University of Wisconsin, Madison, Wis., June 23-26. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Boiler Manufacturers Association. Annual convention at Skytop Lodge, Skytop, Pa. May 25-27. Secretary, A. C. Baker, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineer. Annual summer convention in Asheville, N. C., June 22-26. District meeting at Lake Tahoe, Calif., Aug. 25-28. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Heating and Ventilating Engineers. Semi-annual meeting at the New Ocean House, Swampscott, Mass., June 22-26. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society for Testing Materials. Annual meeting at the Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Refractories Institute. Annual spring meeting at The Greenbrier, White Sulphur Springs, W. Va., May 25-26. Secretary, Dorothy A. Texter, Oliver Building, Pittsburgh, Pa.

Association of Iron and Steel Electrical Engineers. Annual meeting and exposition at the Cleveland Public Auditorium, Cleveland, Ohio, June 15-19. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

1931 Midwest Bituminous Coal Conference. To be held at the University of Illinois, Urbana, Ill., May 21-22. Chairman of Program Committee, B. R. Gebhart, Illinois Coal Bureau, 307 North Michigan Ave., Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago.

National Association of Purchasing Agents. Annual convention and exhibit at the Royal York Hotel, Toronto, Canada, June 8-11. Secretary, G. A. Renard, 11 Park Place, New York City.

National District Heating Association. Annual convention at the Hotel Statler, Boston, Mass., June 2-5. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 8-12. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

Personals

S. M. KINTNER, who has been assistant vice-president of the Westinghouse Electric & Manufacturing Company, was recently elected vice-president in charge of engineering for the company to succeed W. S. RUGG, who was elected vice-president in charge of sales. Well known for his scientific achievements, Mr. Kintner has directed the research activities of the Westinghouse organization since 1920.

DR. ING. FRITZ NEUHAUS, formerly chief engineer and general manager of A. Borsig of Berlin, has opened an office as consulting engineer and manufacturers' representative at 220 Kaiserallee, Berlin W.15, Germany. Dr. Neuhaus was with the Borsig company for more than 30 years and has had a broad experience in power-plant and general engineering in Europe and the United States. Since 1917 he has been president of the German Engineering Standards Committee.

STRICKLAND KNEASS has resigned as chief engineer of the A. M. Byers Company, of Pittsburgh, to become affiliated with the Leif Lee Company, manufacturers of heating and ventilating equipment, also located in Pittsburgh.

THOMAS CLARKSON, consulting engineer of London and inventor of the boiler bearing his name, sailed last week for his home in England after a brief business visit to this country.

C. F. HERINGTON, for the past nine years contracting engineer in charge of sales, engineering and erection of complete pulverized-coal plants for Heyl & Patterson, Inc., of Pittsburgh, has opened an office at 1440 Broadway, New York City. Mr. Herington, who has been engaged in general engineering work for over 25 years, the past fifteen of which were devoted to pulverized coal engineering, will continue to specialize in the design and erection of pulverized coal installations and coal handling systems for power plants.

CYRIL AINSWORTH, who has been in charge of A.S.A. safety code work during the past year, has been made assistant secretary of the American Standards Association to succeed F. J. SCHLINK, who resigned recently to devote his entire time to the technical direction of Consumers' Research, Inc.

GEORGE W. CODRINGTON, president of the Winton Engine Company, was elected president of the Diesel Engine Manufacturers' Association at a recent meeting of the organization to serve out the unexpired term of Alfred E. Ballin, president of the McIntosh & Seymour Corporation, who resigned. At the same meeting the association voted to give a prize of $100 for the best paper submitted to the National Oil and Gas Power Meeting at Madison, Wis., in June.

Business Notes

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., announces the following changes in its organization: J. Morris Ireland, for five years manager of the Cleveland office, has been appointed special representative for the company; F. G. Hickling, formerly transportation manager at Pittsburgh, succeeds Mr. Ireland at Cleveland; and Gordon W. Hamilton, of the Chicago central station sales division, becomes manager of the Milwaukee office, replacing D. E. Webster, who has been made special representative operating from that office.

FIRE KING STOKER COMPANY, Indianapolis, Ind., announced expansion of manufacturing and selling activities following a recent board of directors meeting, at which Murray McConnel was elected president to succeed H. M. Angell, who was elected vice-president, and V. W. Potts was re-elected secretary-treasurer. It was also announced that T. Hopewell, who for the past year has held the position of vice-president and general manager, will direct the manufacture and sale of Fire-King stokers in Canada by the Manitoba Bridge & Iron Works of Winnipeg.

THE BRISTOL COMPANY, Waterbury, Conn., announces the removal of its Pittsburgh office to Kopper's Building, 436 Seventh Avenue.

STEPHENS-ADAMSON MANUFACTURING COMPANY, Aurora, Ill., has enlarged its Chicago office and moved it to new quarters in the Civic Opera Building at 20 North Wacker Drive. C. H. Adamson, secretary of the company, will be in direct charge of sales and engineering for the Chicago territory.

INTERNATIONAL FILTER COMPANY, Chicago, Ill., has moved its general office to 59 East Van Buren St. The company's laboratory remains at its No. 1 plant, 329 West 25th Place.

J. T. DONALD & COMPANY, LTD., Montreal, Canada, are now occupying their new building at 1181 Guy St., Montreal.

ILLINOIS STOKER COMPANY, Alton, Ill., announces the appointment of the Ashmead-Danks Company, 515 Rockefeller Building, Cleveland, Ohio, as its representative in that city.

FOOTE BROS. GEAR & MACHINE COMPANY, Chicago, Ill., announces the removal of its general offices from 111 North Canal St. to 215 North Curtis St., to permit closer coordination of the offices with the manufacturing department.

CHAIN BELT COMPANY, Milwaukee, Wis., has moved its Buffalo, N. Y., office from 753 Ellicott Square to 1807 Elmwood Ave. T. E. Cocker is the district manager in charge of this office.

▼

WITH THE SOCIETY SECTIONS

I.E.C., United States National Committee. Meeting of Section B in the rooms of the A.I.E.E., 33 West 39th St., New York City, on June 2 at 9:30 a.m. Discussion of international standardization of magnetic units, which will be considered at the international meeting in London next September.

A.S.C.E., Boston Section. Meeting at Tremont Temple on May 20 at 7 p.m. Subject: "Fifteen Mile Falls' Lower Development on the Connecticut River," by C. R. Bliss, New England Power Engineering & Service Corporation.

A.S.R.E., Boston Section. Dinner meeting at the Chamber of Commerce on May 21 at 6:15 p.m. Subject: "A Symposium on Insulating Materials," by technical representatives of companies manufacturing low-temperature insulants.

N.A.P.E., New England Association. Annual convention at Worcester, Mass., June 18-20. Secretary, W. B. Powers, 498 Green St., Cambridge, Mass.

Plant Engineers' Club. Dinner meeting at the University Club, Boston, Mass., on May 21 at 6:30 p.m. Subject: "Corrosion-Resisting Alloys," Prof. Albert Sauveur, Harvard University.

▼

Trade Catalogs

BALANCING MACHINES—Full information on various types of machines for statically and dynamically balancing turbine rotors, armatures, fans, crankshafts, etc., is contained in Catalog 50—Part K recently issued by the Tinius Olsen Testing Machine Company, 500 North 12th St., Philadelphia, Pa. Illustrated with many half-tones and line-cuts, the catalog includes in its contents a condensed treatise on the general principles of balancing.

PRESSURE CONTROL—Bulletin H-2, just issued by the Brooke Engineering Company, 1321 Arch St., Philadelphia, Pa., contains several sets of charts taken from Brooke equipment in actual service, which show how accurately pressure or temperature is being regulated under widely varying conditions.

WELDING—The Gas Products Association, 250 East Ontario St., Chicago, Ill., an association of independent manufacturers of gas welding and cutting equipment, has just issued a 44-page booklet on pipe welding. In condensed form this booklet contains complete information on all important phases of the various types of welded-steel and wrought-iron piping systems for industrial uses.

BELTING—The ninth edition of the booklet entitled "The Belt That Puts the Pull in the Pulley" has recently been published by E. F. Houghton & Company, P. O. Box 6913, North Philadelphia, Pa. This publication presents much valuable information on the selection, installation and maintenance of leather belting, together with data on horsepower ratings of different sizes, computation of creep, practical hints on lacing belts, etc.

INDUSTRIAL PHOTOGRAPHY—A new magazine, *Applied Photography*, devoted to the application of still and motion pictures to engineering, industry, research and sales is announced by the Eastman Kodak Company, Rochester, N. Y. The first issue, published May 1, contains noteworthy examples of photography for various business purposes. Each subsequent issue will be devoted to a particular business objective and will illustrate how photography can aid in attaining it.

▼

Fuel Prices

FUEL OIL

Boston—May 11, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.9c. per gal.; 28@32 deg., 4.85c. per gal.

New York—May 14, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

Philadelphia—May 9, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

Pittsburgh—May 12, f.o.b. local refinery, fuel oil, 30@34 deg., 2.75c.@2.875c. per gal.; 36@40 deg., 2.75c.@2.875c. per gal.

Cincinnati—May 12, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—May 8, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 40c.@42c. per bbl.; 22@24 deg., 45c.@47c. per bbl.; 24@26 deg., 47c.@52c. per bbl.; 26@28 deg., 57.5c.@62.5c. per bbl.; 28@30 deg., 65c.@70c. per bbl.

St. Louis—May 5, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.19 per bbl., or 42 gal.; 26@28 deg., $1.325 per bbl.; 28@30 deg., $1.42 per bbl.; 30@32 deg., $1.52 per bbl.; 32@36 deg., gas oil, 2.901c. per gal.; 38@40 deg., distillate, 3.776c. per gal.

Dallas—May 9, f.o.b. local refinery 24@26 deg., $1.05 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.70 @ $1.90
Pool 10, h. gr. low-vol.	New York	1.60 @ 1.70
Pool 11, low-vol.	New York	1.40 @ 1.50
Smokeless, mine-run	Chicago	1.50 @ 1.75
Smokeless, slack	Chicago	1.25 @ 1.35
Harlan, Ky., slack	Chicago	1.10 @ 1.20
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.50 @ 1.75
Ind. 5th Vein, m.-r.	Chicago	1.20 @ 1.75
Standard Ill., mine-run	St. Louis	1.25 @ 1.40
W. Ky., mine-run	Louisville	.85 @ 1.25
W. Ky., slack	Louisville	.65 @ .85
Pittsburgh, mine-run	Pittsburgh	1.35 @ 1.45
Smokeless, mine-run	Cincinnati	1.65 @ 1.75
Smokeless, slack	Cincinnati	1.10 @ 1.25
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.85 @ 1.10

Anthracite (Net Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.25 @ $4.00
Barley	New York	1.00 @ 1.40

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ala., Tuscaloosa — U. S. Veterans Bureau, Arlington Bldg., Washington, D. C., received lowest bid for the construction of a group of buildings, including boiler house, pump house, etc., at U. S. Veterans Hospital here, from Nelson Construction Co., Columbus, Ga. $492,992.

Calif., Arbuckle—Union Ice Co., 354 Pine St., San Francisco, plans the construction of a pre-cooling plant here. Estimated cost $40,000. Private plans.

Calif., Santa Maria—City Council, will soon award contract for the construction of a sewage pumping plant, etc. Y. Peterson is city engineer.

Conn., Hamden—Town will receive bids in June for the construction of a 16 x 18 ft. sewage pumping plant and sewer construction at Spring Glen. Estimated cost $50,000. F. Walden Wright, Town Hall, is engineer.

D. C., Washington—Treasury Dept., Office of Supervising Architect, is having plans prepared for the construction of a new central heating plant and steam and electrical distribution systems to supply heat to 26 buildings. Estimated cost $5,749,000. United Engineers & Constructors Inc., 112 North Broad St., Philadelphia, Pa., are engineers.

Ill., Chicago—Commonwealth Edison Co., 72 West Adams St., is having plans prepared for the construction of a sub-station at 11-15 North Wabash Ave. Holabird & Root, 333 North Michigan Ave., are architects.

Ill., Chicago—Sanitary District of Chicago, is having plans prepared for the construction of a pumping station and blower house for Calumet sewage treatment works. Estimated cost $2,500,000 to $3,000,000.

Ind., Fort Wayne—Indiana School for Feeble Minded, received lowest bid for the construction of a power plant from Buesching & Hageman, 402 East Superior St.; boiler installation from Hipskind Plumbing & Heating Co. Estimated total cost $195,000. R. W. Noland, 408 Cal-Wayne Bldg., is engineer.

Ind., Jasper—City awarded contract for the construction of a power plant to R. Hochgesang, Jasper. Estimated cost $40,000.

Ind., Plainfield — Indiana Boys' School, awarded contract for the construction of a boiler house to F. M. Cooley, 5675 Winthrop St., Indianapolis. Estimated cost $40,000.

Ind., West Lafayette — Purdue University, awarded contract for the construction of a power plant to A. E. Kemmer, Lafayette. Estimated cost $100,000.

Ia., Dallas Center—City defeated $66,000 bonds for waterworks improvements including wells on Racoon River, pumping equipment, etc. W. E. Buell Engineering Co., Sioux City, Engr.

Me., Orono—University of Maine, will receive bids until May 20 for the construction of a coal handling plant, including boilers, stoker, boiler settings, coal handling equipment, etc. Estimated cost $40,000. R. D. Kimball Co., 6 Beacon St., Boston, is engineer.

Md., Cumberland — Mayor and Evitts Creek Water Co., will receive bids until May 27 for the construction of a dam, 726 ft. long and 80 ft. high in valley of Evitts Creek, Bedford County, Pa., two miles north of Gordon dam and twelve miles north of Cumberland. J. E. Greiner Co., 1201 St. Paul St., Baltimore, is engineer.

Mass., Chelsea—Bureau of Yards & Docks, Navy Dept., Washington, D. C., awarded contract for the construction of a refrigerating and ice making plant at Naval Hospital to Vilter Mfg. Co., 2217 South First St., Milwaukee, Wis. $11,185.

Mass., Greenfield—Greenfield Ice & Trucking Co., R. C. Phelps, Union St., is having plans prepared for the construction of an artificial ice plant on Bernardston Rd. Estimated cost $40,000. R. E. Palmer, 58 Suffolk St., Holyoke, Mass., is engineer. Machinery to be furnished by York Ice Machinery Corp., 200 Causeway St., Boston.

Mass., Springfield — Commanding Officer, Springfield Armory, received lowest bid for replacement of steam boiler plant at Hill Shops, Springfield Armory, from A. D. Granger & Co., 15 Park Row, New York, N. Y. $72,444.

Mass., Taunton—Dept. of Mental Diseases, appropriation granted for alterations to boiler house including two 250 hp. water tube boilers and brick stack at State Hospital. Estimated cost $45,000. Engineer not selected.

Minn., St. Paul—City and Ramsey County, G. Bundlie, Mayor, City Hall, will receive bids until June 3 for the construction of a city hall and court house including steam heating system, etc., at Third, Wabasha, Fourth and St. Peter Sts. Estimated cost $3,000,000. Holabird & Root, 104 South Michigan Blvd., Chicago, Ill., and Ellerbe & Co., 525 Minnesota Bldg., are architects.

Mo., Kansas City — Builders Association of Kansas City, 244 Railway Exchange Bldg., is having preliminary plans prepared for the construction of a 30 story builders mart at 9th and Delancy Sts. Estimated cost $6,000,000. C. A. Smith, 800 Finance Bldg., is architect.

Mont., Havre—Great Northern Ry. Co., Railroad Bldg., St. Paul, Minn., plans the construction of a power plant here. Estimated cost $100,000. J. R. W. Davis, St. Paul, is chief engineer.

N. Y., Brooklyn—Dept. of Hospitals, Municipal Bldg., New York, will receive bids about June 1 for the construction of a boiler plant, including boilers, coal and ash handling equipment, etc., at Kings County Hospital here, also for boiler plant at Rockaway Beach.

N. Y., New York—Dept. of Hospitals, Municipal Bldg., will receive bids about June 1 for the construction of a boiler plant at Harlem Hospital. Estimated cost to exceed $40,000.

N. Y., Brooklyn—Twenty Six Court St. Corp., and Chanin Bros. Construction Co., 122 East 42nd St., New York, had plans prepared for the construction of a 25 story hotel at Schermerhorn, State, Court and Clinton Sts. here. Estimated cost to exceed $1,000,000. Maturity about July 1.

N. C., Oteen—U. S. Veterans Bureau, c/o L. H. Tripp, Washington, D. C., is having plans prepared for the construction of a hospital building, power plant, etc., at U. S. Veterans Hospital here. Estimated cost $625,000.

O., Cincinnati—City plans waterworks system and power plant. Estimated cost $2,700,000. Burns & McDonnell Engineering Co., 406 Interstate Bldg., Kansas City, Mo., is engineer.

Okla., Sapapulpa—City is having preliminary plans prepared for rebuilding waterworks pumping plant. Estimated cost $174,982. O. S. Kelley, Oklahoma City, is engineer.

R. I., Newport—Bureau of Yards & Docks, Navy Dept., Washington, D. C., awarded contract for the construction of a central power plant at Naval Training Station here to Coleman Construction Co., 86 Weybosset St., Providence.

Tex., Crystal City—Shippers Co-Operative Co., is receiving bids for the construction of a 150 ton ice plant. Estimated cost $150,000. Private plans.

B. C., Brilliant — West Kootenay Power & Light Co. Ltd., Rossland, has made application for permit for a 30,000 hp. development on the Kootenay River here. Estimated cost $4,000,000. L. A. Campbell, c/o owner, is engineer. This is fifth plant on this river and will complete development of same.

Ont., Oshawa — Ontario Shore Gas Co., W. Chatfield, Mgr., Genosha Hotel, acquired Oshawa gas plant and will extend system, mains, etc., involving new water gas generator. Estimated cost $100,000. Private plans.

Ont., Toronto—North American Life Assurance Co., 112 King St. W., is having sketches made for the construction of a 16 to 18 story office building including steam heating system, elevators, etc., on King St. W. Estimated cost $1,500,000. Marani, Lawson & Morris, 38 Bloor St. W., are architects.

Ont., Westlorne—City Council plans the construction of a waterworks system including pumping station, etc. Estimated cost $75,000. C. R. Hagey, Bridgeburg, is engineer.

Que., Montreal — Royal Victoria Hospital, awarded contract for the construction of a 71 x 106 ft. power house on University St. to Atwood Ltd., 1119 University St.

Hawaii, Oahu—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until June 17 for development of naval ammunition depot including 131 buildings, 11¼ mi. railroads, 14¼ mi. paved roads, electrical, telephone and water supply systems here.

Equipment Wanted

Boiler, Stoker—Wallum Lake, R. I.—State of Rhode Island, Purchasing Agt., Howard, will receive bids until June 1 for furnishing and installing a 250 hp. water tube boiler and accessories, boiler stoker, etc., at State Sanitorium here.

Electrical Equipment—New York, N. Y.—Port of New York Authority, J. F. Galvin, Chn., will receive bids until May 25 for electrical equipment and installation on George Washington Bridge on Hudson River between Fort Washington, N. Y., and Fort Lee, N. J.

Heating Plant Equipment—Waverly, Mass.—Dept. of Mental Diseases, is receiving bids for new equipment including turbine for heating plant. Estimated cost $60,000.

Pumping Equipment—Provincetown, Mass.—Bd. of Selectmen, F. H. Barnett, Chn., pumping equipment for proposed waterworks system. Estimated cost $125,000.

Pumps—Ottawa, Ont.—Bd. of Control, City Hall, will receive bids until June 4 for supply and installation of one 17 m.g.p.d. high lift, one 17½ m.g.p.d. and two 5 m.g.p.d. low lift wash water pumps, for water filtration plant. $20,000.

Pumps—Cairo, Egypt—Dept. of Interior, will receive bids until June 15 for three medium pressure two stage and two low pressure single stage centrifugal pumps, one centrifugal pump, evacuation piston pump, semi-rotary pump, two mechanical filters, two piston type air compressors and nine synchronous motors from 40 to 3 hp. for Deirut plant; also until June 25 for six synchronous motors, from 25 to 3 hp., two medium pressure and two low pressure single stage centrifugal pumps, piston type evacuation pump, semi-rotary pump, etc., for Akhmin plant.

Pumps, etc.—Escanaba, Mich.—City will receive bids until June 3 for mechanical equipment including pumps, etc., for proposed sewage treatment work. Estimated cost $180,000.

Sewage Pumping Equipment—Wichita, Kan.—C. C. Ellis, City Clk., will receive bids until June 4 for sewage screening and pumping station, sludge heating equipment, sludge handling equipment, tanks, drying beds and other miscellaneous appurtenances for Primary Sewage Treatment plant.

Industrial Projects

Ark., Everton—Silica Products Co. Inc., c/o D. D. Dunkin, Harrison, is having preliminary plans prepared for the construction of a silica products plant at Everton. Estimated cost $75,000. Work will be done by owner's forces.

Calif., Los Angeles—Pacific Coast Steel Corp., 215 Market St., San Francisco, acquired a 17 acre site and plans plant extensions, including open hearth, angle mill and enlarge forge pressing facilities at Slauson Ave. and Atlantic Blvd. here.

Conn., Bridgeport—Jenkins Valve Co., 510 Main St., had plans prepared for a 1 story, 65 x 65 ft. addition to plant at Railroad Ave. Estimated cost to exceed $40,000 including equipment. Lockwood Greene Engineers Inc., 100 East 42nd St., New York, N. Y., are engineers.

Ill., Joliet—Bitterman Steel Products Co., F. J. Bitterman, Pres., plans the construction of a 90 x 200 ft. factory on Collins St.

N. Y., Buffalo—Du Pont Cellophane Co., 2 Park Ave., New York and River Rd., Buffalo, awarded separate contracts for the construction of a cellophane manufacturing plant here. Estimated cost $2,000,000. Engineering Dept., Buffalo, in charge.

O., Newton Falls—Newton Steel Co., E. F. Clark, Pres., First National Bank Bldg., Youngstown, plans altering and re-equipping rolling mill here. Estimated cost $1,000,000. Maturity indefinite.

Ore., Warren—United State Gypsum Co., c/o J. H. Nold, Ch. Engr., 300 West Adams St., Chicago, Ill., awarded contract for the construction of a 1 story mill building here, to H. K. Ferguson Co., Hanna Bldg., Cleveland. Estimated cost $200,000.

Pa., Bradford—Kendall Refining Co., J. B. Fisher, in charge, Kendall Ave., awarded contract for re-run still unit to Alco Products Co., subsidiary of American Locomotive Co., 30 Church St., New York; refrigeration system to York Ice Machinery Co., York, Pa., and chilling tower to M. B. Miller, 501 5th Ave., New York. Estimated total cost $154,000.

Pa., Erie—Erie Resistor Corp., H. C. Sherk, Mgr., 644 West 12th St., manufacturers of radio parts, awarded contract for the construction of a 2 story, 32 x 56 ft. factory to H. Rommerdale, 958 West 9th St.

W. Va., Chester — Harker Pottery Co., East Liverpool, acquired plant of Edwin M. Knowles China Co. here and plans to expend $200,000 for three tunnel kilns and factory additions. Equipment will be required.

Ont., Toronto—Fairgrieve & Son, 50 Dovercourt Rd., is having plans prepared for a 2 story, 60 x 130 ft. addition to present sheet metal manufacturing plant. Estimated cost $60,000. A. B. Crealoek, 156 Yonge St., is engineer